JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

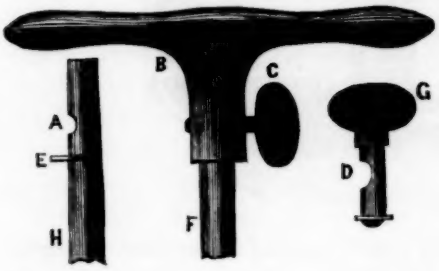
PROMOTION OF THE MECHANIC ARTS.

VOL. LV.] APRIL, 1868. [No. 4.

EDITORIAL.

ITEMS AND NOVELTIES.

Brace and Bit Connection.—We give herewith a cut, showing the details of a simple and effective arrangement for the above purpose, devised by E. Haskell, of this city, and not patented.

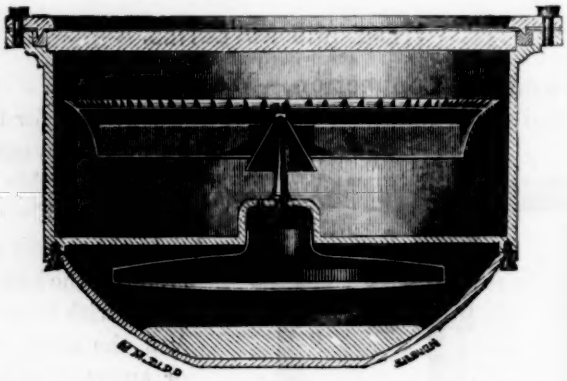


In the middle of the cut is shown the handle of the brace, with its metal socket B, the shaft of the bit or auger, F, and the pin, E, by which the attachment is secured all in their places as when in use. At one side, we have the securing pin, G D, and on the other the shaft of the bit, A H, removed from the socket of

the brace. The shaft of the bit is slightly tapered to fit a corresponding cavity in the brace, and has also a pin, E, which fitting a corresponding notch in the brace, determines its position when introduced, and a cavity or hollow, A, corresponding with the diameter of the pin, D. The pin has also a hollow, corresponding with the shaft of the bit, and is fitted into the socket of the brace, to one side of its axis, so that when the hollow of the pin is toward the axis, there is a free passage for the shaft of the bit. When, however, the pin is revolved in the corresponding hollow of the bit, it receives it in place. A pin running through the end of this pin, serves both to hold it in place, and by bearing against a projection on the outside of the socket, serves to indicate the position when the pin is so adjusted as to admit or release the bit.

The Liquid Compass, of Mr. N. S. Ritchie. This instrument is designed to avoid the evident and serious derangement which the ordinary compass suffers, when exposed to sudden movements, changes of motions or shocks, such as will constantly occur at sea, from the pitching or rolling of the vessel, or the irregular action of machinery in the case of a steamer.

We do not here mention this instrument as a *new* thing, but rather as an invention which, in addition to its merit of ingenuity, has the additional claim to our attention, that it has stood the test of practical use, and has been fully approved by practical experience.



While the apparatus is well known among those most concerned (some 2000 of these compasses being in use already on vessels of all classes in the merchant service, independent of war ships), and while its efficiency, as this fact alone shows, is fully established and recog-

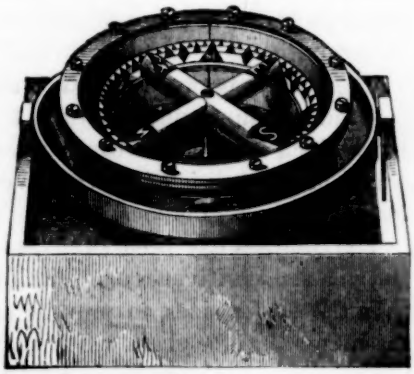
nized, no description has ever been published by which those interested in scientific subjects, and the world at large, can obtain information with regard to its structure and principle.

We therefore regard the space needed for a description of this instrument, as most judiciously applied when devoted to that subject.

The bowl is made of brass, with glass top made perfectly tight by means of a rubber band.

Beneath the bottom of the bowl, and within a convex cover, is a thin, metallic elastic bag, capable of holding twice the amount of expansion for change of temperature from 0° to 100; this bag opens into the bowl, and is soldered to it. When the compass is filled, the liquid is placed under the receiver of an air-pump, and most of the air contained in the liquid is drawn out to prevent possibility of any bubbles. The card is made of two or more cylinders of very thin tinned brass; the usual form is that of two such cylinders, placed at right angles to each other, one of which contains the magnetic needles; a ring of thin brass of the form shown in the cut, surrounds these cylinders, and closes the ends. A cone for the agate cap is placed in the middle.

The closed cylinders are thus made air-tight, and form buoyant air-vessels; the size is made so that the volume of water displaced, is a little greater than the entire weight of the whole, including the needles; small pieces of lead are attached below, which are cut so as to bring the weight to the desired amount over that of the liquid.



The needles are made of thin steel, of six or more sheets lying side by side, placed with their edges up and down; they are bent in the middle so as to go round the cone, as shown in the cuts.

The needles are magnetized after the card is painted, by a powerful electro-magnet, which not only charges the steel to saturation, but the possibility is thus removed of any of the plates being wrongly charged.

In some cases, the needles are enclosed in two parallel cylinders,

at 60° distant, and, to gain a greater amount of buoyancy, and also to reduce the size of the cylinders, the outer ring is made hollow. In the smallest boat compasses, only one cylinder is used, and the hollow ring retained.

In all, the needles are placed below the centre of the cylinders, so that the centre of gravity of the whole is below the centre of the mass, or centre of buoyancy; by this means, although the whole may bear little or not at all upon the pivot, yet the ring will retain its horizontal position, and if displaced quickly, return to it.

The cards are weighted so as to sink in *all temperatures;* this makes the card rest upon the pivot with a pressure of from 20 to 80 grains; the medium size 8-inch card at 60°, bears with a weight of about 50 grains, or about 3 grammes. This slight pressure is enough to retain the card centrally in the bowl.

The friction is thus reduced to the amount that this pressure of 3 grammes can produce, and the force that can be exerted by any blow which the compass can receive, or by the motion of the vessel, which must be resisted by the pivot, can only be that equal to the inertia of the 3 grammes.

The compass has been subjected to a fall of ten feet and more, and yet the sensitiveness not diminished.

In the larger sizes, to prevent any effect from the vibration of the bottom and the glass (which at the maximum may be $\frac{1}{5}$th inch), the pivot is a rod movable in a tube, with a spring capable of bearing 200 grains, and has a range of $\frac{1}{20}$th of an inch. The firing of a gun or a violent blow, may bring this into play.

The inertia of the liquid, and the very slight friction of the sides and bottom of the bowl, prevents it receiving any perceptible motion by any change in the direction of the vessel, (this can be shown by throwing some paper chips into a tumbler of water and turning it

round) and oscillation of the needle in the roughest sea is impossible, yet it opposes no resistance to the needle's obeying the polar force.

After years of constant use, there is no perceptible wear to the pivot.

Electric Gas Lighters.—One of the most useful and successful applications of statical electricity ever made, indeed we may fairly say, *the most* useful, is found in the various forms of apparatus devised by Mr. Robert Cornelius, of this city, for the above purpose.

In the accompanying cut, we illustrate one of the most usual forms.

In the first place, there is a bracket of the usual sort, except that it is provided with two stop-cocks, one with a small handle, D, which

is used simply for adjustment, so that the gas may not come through with too great violence when the other is turned full on.

Upon the upper part of this bracket is fixed, by an insulating piece, C, made of hard rubber, a brass vase, B, lined internally with silk. Within this vase fits a plug of hard rubber, with a metallic cap and knob, A. From the metallic vase, B, runs a wire, I, termi-

nating in a platinum point, H, which is sustained at the side of the burner by an insulating support.

When the plug of vulcanite is inserted in the vase and slightly moved about, electricity is excited by friction, a negative charge being acquired by the vulcanite and a positive charge held by induction to the inner surface of the brass vase. This charge is, however, entirely fixed to the inner surface of the vase by the attraction of the negative surface of the vulcanite, and does not tend to escape, even though the brass cap of the plug, A, touches the rim of the vase, and thus makes, through the hand, a connection with the ground. When, however, the plug is withdrawn, the charge in the vase is liberated and passes, by the only circuit then open, through the wire, I, by a spark into the burner, and so to the ground.

After the vulcanite has been once charged, it is no longer necessary to produce any friction, merely replacing it in the vase will cause an induced charge to collect in the vase, positive fluid being drawn from the hand through the brass cap then in contact with the edge of the vase.

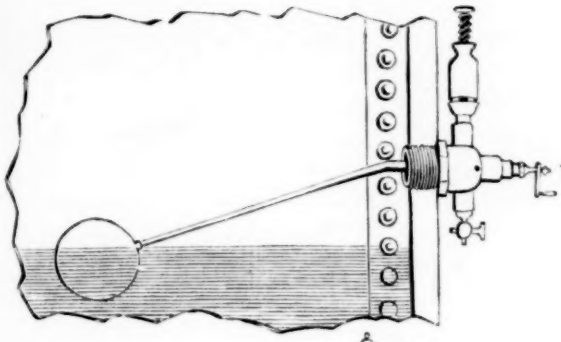
With regard to the efficiency and reliability of this apparatus, we can speak both from experience and report. In one of the lecture-rooms at the University of Pennsylvania, the burners are provided with these attachments, and during the past year, summer and winter, we have been constantly in the habit of entering in the dark and securing a light without fail, by this means.

Several of our friends have, for many years, employed the same apparatus with a like result, and unite in the opinion that, with any reasonable amount of care and judgment in its management, it is eminently reliable and convenient.

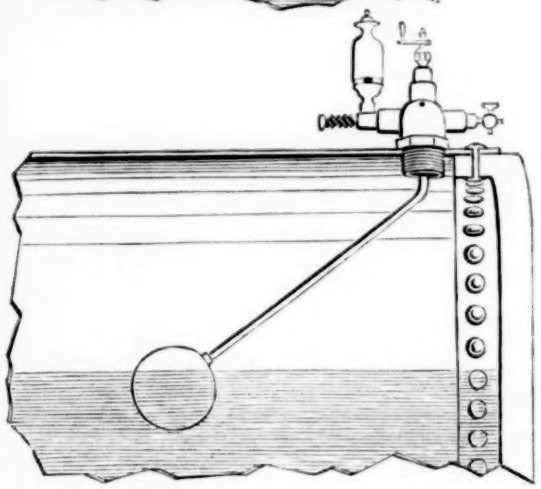
The same principle has been applied by Mr. Cornelius in the construction of electric lightning wands, and other forms of the apparatus, exhibiting great ingenuity, and also thoroughly effective.

An Improved Low Water Detector and Alarm, the invention of, and patented by, John Cosfeldt, of Philadelphia, June 13, 1865.

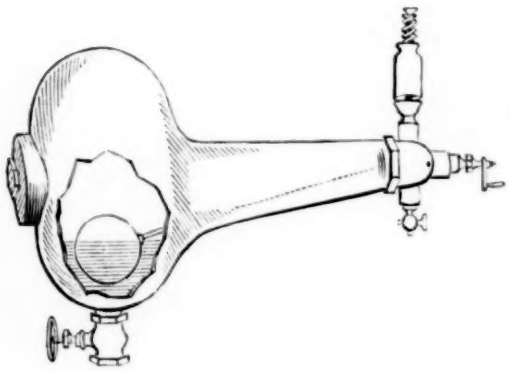
This instrument is composed of a chamber, screwing into the head or the top of the boiler, into which from the inside of boiler is introduced a lever, to which a float is attached, operating on a valve in said chamber as the water recedes, causing an opening for passage of steam to blow the whistle. This valve is operated simply by leverage. The instrument is in all its parts non-corrosible, and not liable to get out of order. In applying it to the boiler, the attachment is made in *dry steam*, and not below water.



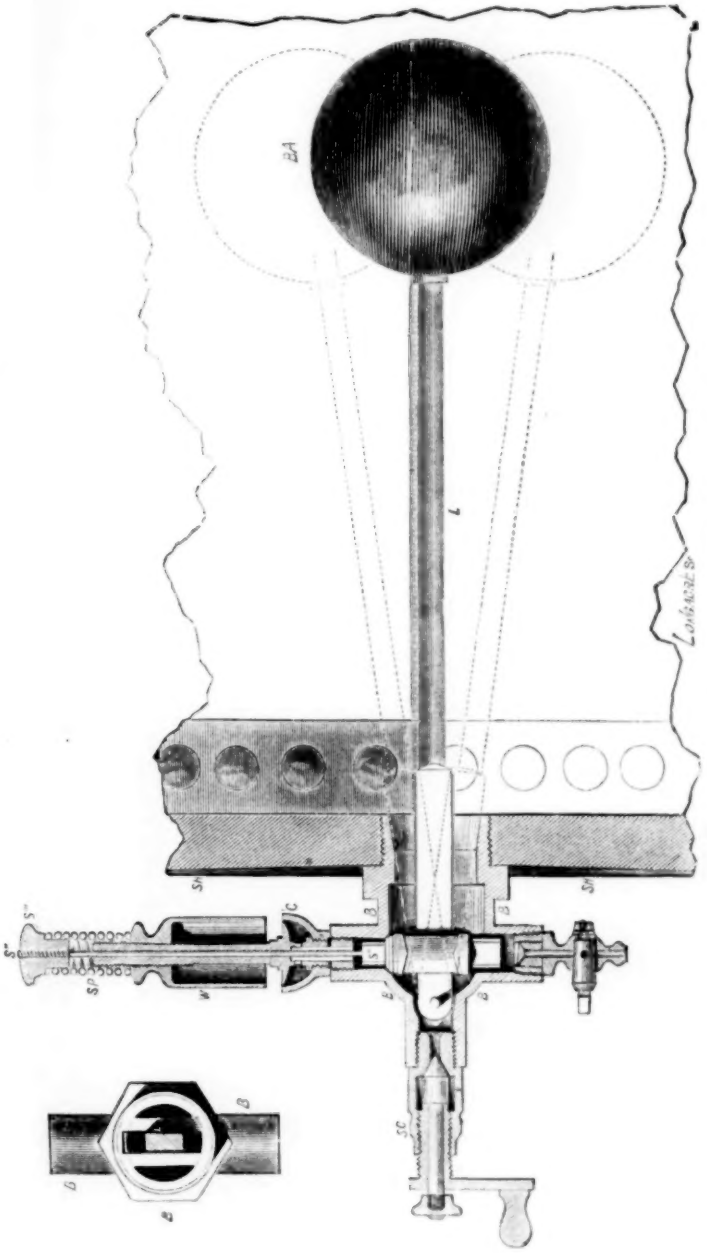
No. 1 Style.
Working in Head of boiler.



No. 2 Style.
Working on Top of boiler.



No. 3 Style.
Cast Iron Chamber with Detector working inside.



THE COSFELDT PATENT LOW WATER DETECTOR.

For boilers where it is inconvenient or impossible to apply the detector in this form, there is another style, viz: a cast iron chamber to be attached externally, in which the detector operates.

A model boiler, with detector working, can be seen at the office of the Cosfeldt Patent Low Water Detector Company, of Pennsylvania, No. 132 South Third Street, Philadelphia.

Skeleton Grate Bar.—[We have received the following account of this apparatus from one well acquainted with its use, accompanied by a weighty mass of testimony.—ED.]

FIGURE 1 shows a longitudinal, and Fig. 2 a transverse section of the Skeleton Grate Bar. The column of cold air passes up both sides or surfaces of the bar, at the same time through the longitu-

Fig. 1.

dinal opening, A, as shown at the bottom of the cut, then passing out at the side holes, B, performs the double purpose of cooling the bar, and evenly distributing the air.

Many patents have been granted for alleged improvements in bars for furnaces. These changes of pattern appear to have been designed more to please the eye than to effect any useful object.

Fig. 2.

The Skeleton Bar, while preserving the general external form of ordinary bars, are made with special regard to the scientific principles of combustion.

1st. A positive and radical improvement has been introduced. It consists of the channel (as shown in the engravings) running the whole length of the interior of the bar, in connection with the holes at the sides.

2d. Durability.—The trough-like form is calculated to resist warping or twisting; while the rapid and constantly changing current of air through the heart of the bar, tends to preserve it from the effects of the fire.

3d. Better combustion and consequent economy of fuel.—The vitality of fire depends as much upon the oxygen derived from the air, as upon the carbon or bitumen of the fuel used. Scientific and practical men have long been aware that the supply of air through

the interstices of grate bars has been lamentably deficient, and a serious waste of fuel the result. The peculiar construction of the Skeleton Grate Bar allows of the passage of a much greater volume of air than is permitted to pass by bars of the ordinary sort, of the same cross-section and distance apart.

The free access of air is useful in several ways. It lowers the temperature of the bar.

It enables the use of a smaller size of coal, reducing the cost per ton for fuel.

As the heating power of fuel is derived from the combination of its elements with oxygen, which oxygen is obtained from the air, it is of the greatest importance to secure a full supply of air.

Perfectly burned carbon produces carbonic acid, that which is burned with an insufficient supply of air forms carbonic oxide, which gas passing off by the chimney, is the source of great waste of fuel. To ensure perfect combustion, that portion of the air which is required to pass through the fuel, should be as thoroughly distributed over the whole grate surface as is possible.

If the spaces between the grate bars are not free and open, the air enters with large volume at a few points, causing great heat in those localities, and favoring the formation of clinker, and even melting the bars; and on the other hand, if the grate bars be not equally and well covered, the air will enter and pass those parts more thinly covered, where it is least wanted, and where it should be most limited in amount.

The Skeleton Grate Bar allows the use of a greater depth of fuel than the ordinary bar, and thus gives greater security that the bars be fully covered, and not liable to the above objection. The importance of furnishing a suitable supply of air to convert all of the carbon of the fuel into carbonic acid, in order to obtain the most economical result, is very readily shown.

In the conversion of one part of solid carbon into carbonic oxide, there are involved 2,473 heat units. In the conversion of the carbonic oxide thus obtained, into carbonic acid, there are involved 5,607 heat units, making 8,080 heat units in all, of which the first or imperfect combustion yielded but thirty-one per cent. of the obtainable heat; so that to limit the supply of air so as to cause the exclusive production of carbonic oxide, would necessitate the use of three times as much fuel as would be required to do the same work were it properly burned. The perfect combustion of one ton of anthra-

cite coal or of coke, requires over 5,970 pounds of oxygen, derived from about 340,000 cubic feet of air at ordinary temperature, equivalent to a column one foot square and over sixty-four miles in length. This calculation is based upon the supposition that all of the oxygen of the air is made available, but in practice it is found necessary to introduce twice the quantity of air that by calculation would be sufficient.

Another result of the ability to introduce a larger amount of air with the same force of draft, is that of using fuel of a smaller and cheaper sort. If we suppose the fuel to consist of cubes, four inches on each side, we should have twenty-seven such pieces to the cubic foot, with an aggregate surface of 2,592 square inches, requiring a fixed amount of air per minute for its proper combustion. If, now, in place of the four-inch cubes, we substitute others of one inch on each side, we will have 1,728 to the cubic foot, and a total surface of 10,368 square inches, or four times as great a surface exposed to fire contact. Consequently, to obtain the same intensity of combustion, there will be required four times as much air in the same time to burn the small fuel, as will be required for the larger fuel, or else we must diminish the thickness of the layer of fuel upon the bars, so that in burning the smaller coal it shall be but one-quarter the depth of that employed in burning the coarser sort.

The adoption of the Skeleton fire bar affords a valuable aid in securing perfect combustion and economy in the use of fuel, from its ability to allow of the passage of a larger volume of well distributed air, than is done by the bars in ordinary use.

Smith & Ellis, sole manufacturers in Philadelphia. Foundry—York and Moyer Streets. Office—35½ South Front Street.

Office of the Company, 501 Commerce Street, Philadelphia. John McCartney, President, Jos. S. Fisher, Treasurer and Secretary.

Ozone.—(A new experiment, illustrating its peculiar property of energetic affinity). Our attention was drawn to the above subject, by a very youthful physicist, Master Chas. J. Gibbons, who was led to the observation in the following manner: He was provided with one of those judicious collections of chemicals and apparatus packed in a small box, known as Crew's Laboratories; and among other experiments possible therewith, was trying the development of ozone, by the action of a heated glass rod, upon a mixture of air and ether, only that he had varied the experiment by substituting

oxygen for air and a glass tube for a rod. Under these conditions, a tremendous detonation was the result of the introduction of the heated tube into the mixture. Nothing daunted, however, by this at the least, startling phenomena, he repeated the experiment, supposing that perhaps the glass might have been too hot, but again—with a tube that could be drawn through the closed hand without burning, the explosion followed as before. A glass rod was then tried, but produced no such result, even when at a low red heat.

The conclusion was obvious. The portion of mixed gas and vapor inside the tube, being confined, was so completely acted upon, that ozone in sufficient purity and bulk to ignite the vapor or mixture was produced; while in the case of the rod, that part of the oxygen converted into ozone at each instant, was too rapidly diffused and diluted for such a result.

A New Galvanic Battery is described in the last number of "*Les Mondes*" as follows: M. Boćttger has published in a recent article a mode of constructing voltaic batteries, which has the advantage of being simple and of small expense. It is particularly applicable where a constant current is desired; as for example, for electric clocks. It consists of a jar of glass or earthenware, into which is introduced a hollow cylinder of zinc, containing a cylinder of coke. These two cylinders do not touch, and the space between the two is filled with a mixture of common salt and sulphate of magnesia in a moist condition.

The cells or elements are then connected in the ordinary manner.

A New Thermometer, which is not affected by radiation, has lately been devised by Dr. Joulé.

It consists of a copper tube surrounding another tube, which is open at the top, and having a hinged bottom; in the smaller tube is suspended a fine wire in a spiral form, suspended by a silk thread, upon which is a small mirror. When the bottom is closed, the mirror stands at 0°, but when open, the air inside being usually warmer than the outside atmosphere, a current is established, twisting the silk. One degree Fahrenheit, causes a complete turn of the mirror. The cause assigned by the author for this elevation of temperature inside the copper tube, is, that the copper absorbs light and heat from the atmosphere, and causes an internal radiation.

Editorial Correspondence.

RAILROAD NOTES.

NEW YORK, *March*, 1868.

CONSIDERING the general depression hanging over the country, the railroad interest is remarkably active, and indeed since railroading was first started, I do not think there ever was such activity as at the present time in this important department of internal improvement. This is certainly true of the country in and around New York, which point seems to be the *ultimathule* of almost every railway in the country, in some way, directly or indirectly. The following notes embody a synopsis of the numerous projects in all stages of development, in what may be called the vicinity of the metropolis.

The Boston, Hartford, Erie Railroad is intended to bisect the State of Connecticut as near as may be, and striking the Hudson River at Fishkill, there connect with the Newburg branch of the Erie road. There are eleven north and south roads bisected in its course; all important business connections. This road has not a very straight alignment, as will be noticed by tracing its course eastward from Fishkill, through Danbury, Waterbury, Hartford, Willimantic, Mechanicsville, Blackstone to Boston, a distance in all of some 220 miles. The surveys show the curves to be comparatively light, with a maximum grade ascending east of 60 feet per mile, while that of the ascending western grade is 66 feet. The highest summit is 763 feet, and lies in the range of hills between the Hudson and the Harlem Railroads. A goodly portion of this line is already completed, and the authorization of the Massachusetts Legislature for a $3,000,000 loan, with as much more in bonds guaranteed by the Erie Railway Company, seem to promise an early opening over the whole route. The estimates are published at $45,000 per mile, and the projectors are sanguine of a great and increasing traffic.

The Erie and New England Railroad is designed to connect "Turner's" on the Erie Railroad, with Derby, Connecticut, in a nearly due east alignment. This road will be 60 miles long, 22 of which are in Connecticut. To be graded to accommodate both the narrow and wide gauge, and is intended to cross the Hudson at or near Peekskill, over the "Highland Suspension Bridge," which, by the way, is blocked out, as below, by Gen. Edward Serrell, of "New York Engi-

neer Regiment" fame, whatever that was. Clear span, 1600 feet. Total length, including approaches, 2,499 feet; elevation above high water, 155; height of towers above high water, 280 feet; with several thousand miles of steel wire in the cables, which are to be in four systems, each cable being 14 inches in diameter. To carry safely 35,000 people and 60 locomotives.

The Spuyten Duyvel Railroad is intended to connect Commodore Vanderbilt's two roads, the Hudson and Harlem, and will be begun this Spring. It is an important link of about five miles, and is estimated at $50,000 per mile.

New York Housatonic and Northern Railroad is a short line of 40 miles, and leaves the Harlem Road near White Plains, and runs northward through North Castle, Bedford, and Cross River; thence through North Salem, Ridgeberry, and striking the Housatonic line at Brookfield. The Engineer reports 70 per cent. of the route straight, the minimum curvature 1146 feet, and the maximum grade 60 feet to the mile. The estimate for business places "milk" about 50 per cent. of the whole, so that it will be essentially an "iron tailed cow." The whole line is under contract, and expected to be finished in a year from now.

The Dutchess and Columbia Railroad starts from Fishkill, on the Hudson, running through the counties from which it takes its name, to a point on the Harlem road, a total distance of 63 miles. This is a very inexpensive line to construct, and is now under contract. Two-thirds of the line is straight, the maximum grade being 53 feet, and but two unimportant bridges occur in its whole length. It occupies a good location for business, and promises to be remunerative.

The Western Connecticut Railroad, is a proposed route from Springfield, south-west through Granby, at which point they tap the Salisbury iron mines; thence to New Hartford and Winsted. It comes over into New York, striking the Harlem road at Amenia, and finally joins the Dutchess and Columbia road near Washington Hollow. The grade is reported to be the best as yet surveyed between Long Island Sound and the lakes, for an east and west road, with but one instance of the grade exceeding 60 feet, and that is for about three miles on the eastern side, where it is 80 feet to the mile. The curves are remarkably easy, and the grading unusually light.

New Haven and Derby Railroad is a short line of but 10 miles, and is of course designed principally for local accommodation. It

is now being graded with expectations of being finished the coming fall. There is a considerable amount of grading on the line, especially that portion passing over an ugly marsh, which it does for over a mile, and over which the grade is carried on piles.

The New Haven, Middleton and Willimantic Road, is located to connect New Haven and Willimantic, which latter point forms one of the links in the chain of the Boston, Hartford and Erie line. The line is 51 miles long, and is to be laid with steel rails, laid with the Smith or Hudson River joint. As the intention is to make this road part of an air-line, between New York and Boston, the plant and fixed constructions will be of the most durable character, and in which no expense will be spared to make them what they should be. A large and important bridge-crossing will be necessitated by the Connecticut River, and the original intention was to construct a suspension bridge of 900 feet span, high enough above high water as not to impede navigation. The Legislature of Connecticut has been petitioned to allow of a low grade bridge, with a draw presenting water-ways of 125 feet. This has not been granted, and is hardly possible this session.

The Midland Railroad is intended to shorten the distance from New York to the lakes, avoiding the circuitous Erie and Central roads. As the intention is to build this line by communities, that is by towns subscribing in their corporate capacity, and not by individuals, some time was required to locate a direct line and satisfy those villages and towns that subscribed to the stock. In general direction, it bisects the region of country between the Erie and New York Central roads. The eastern terminus will probably be at Hoboken, on Mr. Stevens' property. Probably the coming six months will see the whole line under contract. The country traversed is a rolling one, but the maximum grade has been limited to 65 feet to the mile, as this line when completed will form an important route to the West, saving at least two hours over the Erie road. A connection is contemplated with the Highland Bridge, for a Boston outlet.

The Hudson River West Shore line occupies the ground indicated in its name, connecting at Athens with the already built and operated Athens road, and will form an important rival to the Hudson River Road. The General Government has given the right of way through the West Point property, and the Company has bought the Northern Railroad for their southern link to Jersey City, which leaves but a moderate amount of new road to construct.

The New Canaan Railroad will run from Stamford, Connecticut, on the New York and New Haven Railroad, northward to the village of Canaan. This road is only eight miles long, with very light work, and the grading is now ready for the iron.

The Lebanon Springs Railroad was commenced in 1863, and after $300,000 had been expended, work was discontinued. Operations were resumed some time since, and now more than half the road is ready for the iron. This road really forms an extension of the Harlem from Chatham-Four-Corners, to Bennington, Vermont, where it connects with the Rutland and Bennington Railroad. When completed, there will be an air-line between Montreal and New York, and there is every probability of this being an accomplished fact the coming summer. The distance traversed by this Lebanon Springs Road is 54 miles, in a nearly straight alignment, the longest bridge being but 200 feet.

Kinderhook and Neverville Railroad, is designed to connect Hudson, on the Hudson River Road, to Neverville, on the Boston and Albany Road, a distance of 16 miles, and is expected to be built for $500,000. Short as the line is, it traverses a fertile country, and promises to be a paying investment.

The Walkill Valley Railroad, is a continuation of the Montgomery and Erie Railway (which leaves the Erie road at Goshen). It is a broad guage road of 12½ miles, and will eventually be extended to Kingston, where it will connect with the Rondout and Oswego roads.

The Goshen and Deckerton Railroad, is the northern continuation of the above Walkill Valley road. The intention is to run from Goshen to the State line of New Jersey, some 13 miles. Here the extension of the Sussex and Branchville road will be met, which will enable coal to be sent from Pennsylvania mines into Orange County, without breaking bulk.

The Vernon Railroad now being operated as a feeder to the Morris and Essex road at Waterloo, is to be extended northward to Franklin, 12 miles; thence, by Hamburg and Vernon, to Warwick, when connection will be made with Warwick and Newburg branches of the Erie Railroad for other eastern ramifications, distributing Pennsylvania anthracite coal vastly cheaper than can be afforded by the present lines of traffic. It is in fact an air-line link to west and south-west from the Eastern States, and of which the Lehigh roads form part.

New York and Newark Railroad is intended for local accommodation merely between those cities, and is located in a straight line from one end to the other, being at least seven per cent. shorter than any of the existing lines. It is in the hands of the New Jersey Central Company, and strikes their ferry at Communipaw. In such a line, it has unusual obstacles to overcome, in the crossings of the Passaic and Hackensack rivers, as well as a long, deep trap-rock, cut through Bergen Hill, of the same character as that through which the Erie tunnel was pierced; which, by the way, afforded singularly fine specimens of certain zeolite minerals. Rapid and light trains at intervals of fifteen or twenty minutes, are expected to attract a large proportion of the travel to and from Newark. The river bridges will both have "draws" in the channels, of the "Mosely arched rib pattern," slung with hog chains from standards. The balance of these bridges will consist of piling. Maximum grade allowed is 21 feet, on account of the character of the proposed plan of operating, noted above.

The Patterson and Newark Railroad runs up the Passaic Valley from Newark, connecting with Erie road at Patterson, and will be of considerable advantage to New Jersey manufacturers in shipments of Western freights, saving the expense and trouble of shipping to New York, and those making transhipments.

The Vineland Railway is a projected line of 60 miles, to open up the rich trucking districts of southern Jersey to the New York markets, via the Pemberton and Hightstown Railroad. Its alignment and connections guarantee a large freight and passenger traffic.

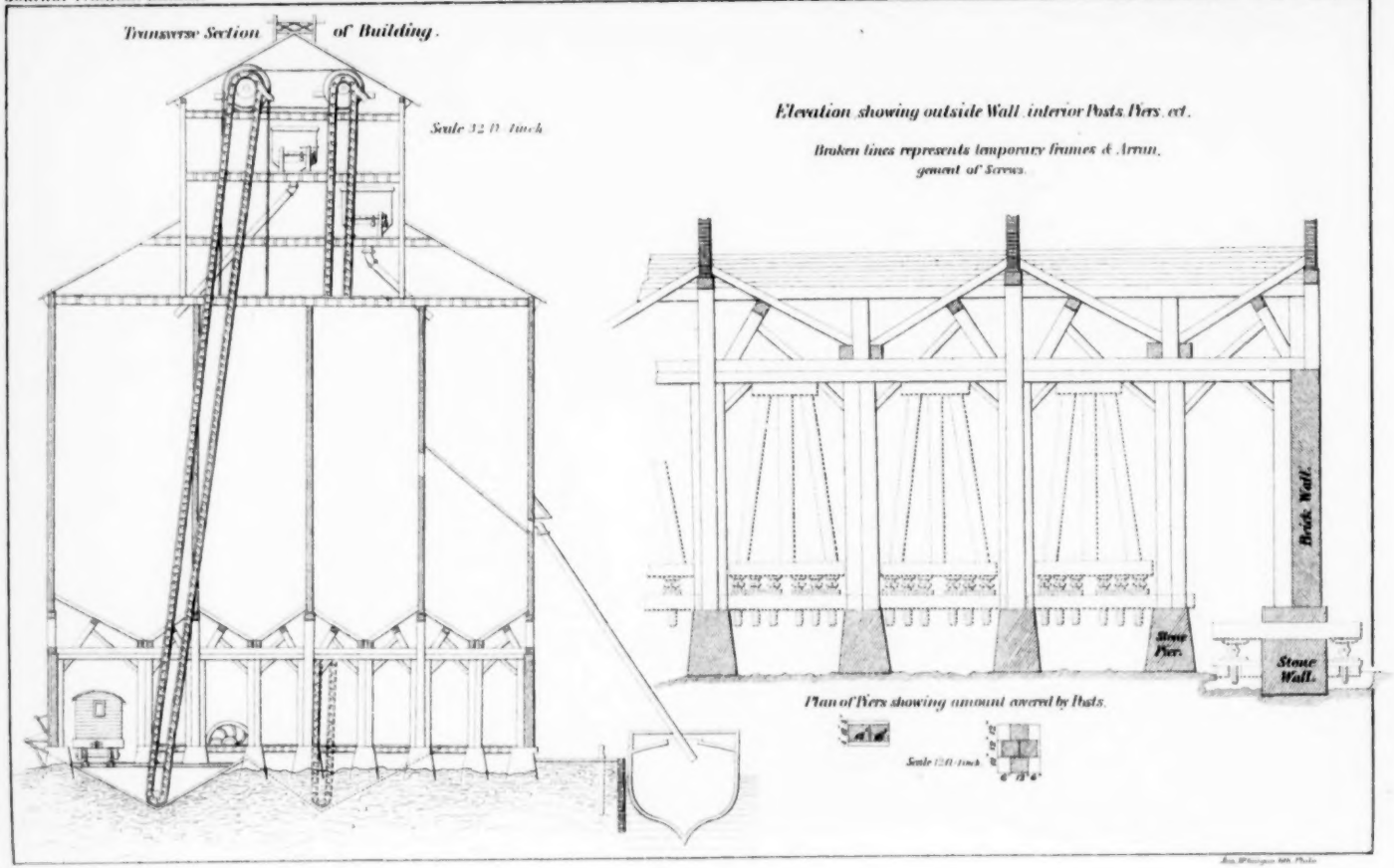
The Monmouth County Agricultural Railroad will connect Freehold, New Jersey, with Keyport, on the Raritan Bay, a distance of 14 miles, and is estimated at $15,000 per mile.

The Rondout and Oswego Railroad is composed of numerous links of already existing lines, together with 95 miles of new road to be built from Colliersville, on the Albany and Susquehanna road, to Rondout, on the Hudson, making a total distance between the objective points of some 221 miles. But 73 miles of the Eastern division are definitely located, and with the exception of the Catskill Mountain crossing, the grades are very favorable. On the mountain division, a tunnel of 1600 feet will be required. The estimate averages $40,000 per mile.

In conclusion, I send a memorandum of the New Jersey Pneumatic Transportation Company.

The New Jersey Pneumatic Transportation Company.—Although the mode of transportation designed to be employed by this Company does not exactly belong to the same class as railroads, it nevertheless seeks to obtain the same results as locomotive roads, and differs from them in principle only in the motive power. The subject of moving valuables, light freights, parcels, and mail matter at a higher rate of speed than can be attained by any of the methods now in use, in this country, had long occupied the minds of engineers and others, when in May, 1867, the Company above mentioned was incorporated, and received a charter from the State of New Jersey. The franchise gives them the exclusive privilege of laying pneumatic pipes in that State, fixes the capital stock at $500,000, and requires that at least ten miles of pipes shall be constructed within three years. The Company proposes to lay part of the required ten miles from Jersey City to Newark, along the line of one of the railroads now in operation between those points. The tube is to be of wood and three feet in diameter, but the details as to carriages, engines, and so forth, have not yet been decided upon. It is expected to be able to transport articles at as high a speed as one hundred and fifty miles an hour, and to have perfect control over the carriages, stopping them at pleasure and at any place. The pipes may be laid in curves, and over grades, and can be constructed for $30,000 a mile. After the success of the enterprise is practically demonstrated, the Company proposes to lay tubes to Washington, and thus secure the carrying of mails from that city to New York, and also of money parcels and other small packages. In this connection, it may be proper to mention that a Company has just been organized, styled the New York, Jersey City and Brooklyn Pneumatic Transit Company. The design is to lay pipes from Brooklyn, under the East River, through New York and under the North River to Jersey City. The tube in this case is to be six feet in diameter, with the intention of transporting passengers as well as freight. Whether the greater rapidity and saving of time by this means would induce people to prefer it to the ferries, is a matter yet to be determined. The project is now before the Legislature for a charter.

A. P. B.


Transverse Section of Building.
Scale 32 ft. 1 inch.
Elevation showing outside Wall interior Posts Piers ect.
Broken lines represents temporary frames & Arrangement of Screws.
Brick Wall.
Stone Pier.
Stone Wall.
Plan of Piers showing amount covered by Posts.
Scale 12 ft. 1 inch.

Civil and Mechanical Engineering.

THE RAISING OF THE GREAT GRAIN ELEVATOR BUILDING, AT MILWAUKEE, WIS.

By D. J. Whittemore, CE.

This building, situated on the banks of the Menomomee River, at the eastern terminus of the Milwaukee and St. Paul Railway, in the city of Milwaukee, is the largest, and by many persons conceded, the most convenient building in the world devoted exclusively to the receiving, storing and shipping of grain.

Its capacity is 1,250,000 bushels. Size, 280 feet long, 86 feet wide, and 130 feet high.

To a certain extent, a description of its construction is necessary, to properly understand the remarks which follow:

The plan of the storage bins, consists of dividing the length of the building into twenty-eight equal spaces, and the width into four parts, by partitions, constructed in the usual manner, of two-inch plank lying flat-wise on and breaking joints with each other, thoroughly spiked together, and thus built up to a height of sixty-one feet.

In the interior of the building, this work rests on a frame of oak beams, supported by clusters of posts, alternating two and four posts in each cluster, every ten feet apart from centre to centre, throughout the entire interior. The posts are 12×16 inches in size, 15 feet long, and rest on stone piers, built up from a pile foundation. The first or business floor, is at the top of the stone piers, on which the posts rest. The next floor is at the top of bins 76 feet above first floor. The foundation of the outside wall is piled, on which a stone wall 4 feet thick and 5 feet high rests. On this is placed the water-table, and then a brick wall 20 inches thick, and 15 feet high, to the under side of the frame work, supporting the wall of the bins. That portion of the building above the bins is built of frame, 40 feet wide, 270 feet long, four stories high, and is used for machinery, distributing and weighing grain, &c.

Notwithstanding this building rests on 9000 piles, averaging 30 feet long, it began to settle soon after it was completed, in the beginning of the year 1865, and in the summer of 1867 was found

to be so low, in several parts, as to preclude its being worked to its proper capacity, on account of many of the lower receiving hoppers being below the level of the water in the river. At this time, the greatest settlement at one point was $2\frac{17}{100}$ feet. It appeared that this settlement was not caused by the piles slipping through the earth into which they were driven, as the surface earth had the same relative height to the building as when it was constructed, but was owing to the compression of the substratum. This was rendered apparent by the alteration of the heights of the railway tracks in the vicinity. One of my "bench-marks," used as a datum in taking levels, situated on a pile driven 30 feet into the ground, and distant 100 feet from the building, opposite where it had settled the least, went down three-fourths of one inch in twenty-eight months, with no weight upon it.

Judging from borings, it is believed that the substratum in which this compression takes place, consists of peat, intermixed with a large proportion of sand.

On the 20th of June, 1867, it was decided to raise the building, and by the 27th all grain in store was removed from it, and work commenced inside and out. It may be well to state, that prior to the commencement of the work, the party in charge stipulated to have the same completed in season to accommodate the grain traffic of the year, which would commence on or about the 20th of August.

The first work done, was the laying inside and outside of the outer wall of the structure, a foundation of timber on the earth. Cutting through the four feet thick stone wall, directly under the water-table, and inserting beams twelve inches square and ten feet long, each end projecting on either side of the wall, over the foundation timbers before mentioned, between which and the beams, screws were inserted. These beams were put through the wall as near to each other as practicable, and resulted in placing the weight of the outside walls entitely upon the screws. This process was simple, compared with the arrangement necessary in the interior. At each cluster of posts, the stone piers had a top area only a little larger than that covered by the posts. In a majority of instances, the pier projected only from four to six inches outside of the posts. To secure an even foundation for screws, that perforce had to be some distance apart, to prevent, in measure, settling of foundation, bringing a great strain upon a small number of screws, and thereby

crushing them, the plan was adopted of using these four and six-inch vacant parts of the pier tops, instead of the ground, as a foundation to work upon. To this end, timbers were laid across from pier to pier throughout, and bridged in a secure manner. On this the screws were placed. Between each cluster of posts, a frame was constructed of timber, 10×12 inches in size, consisting of three posts sill and caps resting on the screws, the posts extending from said sill to the under side of the beams, on which the structure above rested. The cluster of posts were made fast to the beams above, so that they would raise with the building. Levels had been taken on top of each pier to ascertain the proper height to raise, and thickness of pier caps to be introduced under posts.

When this height was less than one foot, cast iron cellular blocks were used. In all other cases, stone, in one piece of the requsite size. These were all provided, marked and numbered, each for its particular place beforehand. To provide, to a certain extent, for future settling of the structure, the rule was adopted to raise the building at all its parts one-quarter as much above the true plain of foundation, as such parts had settled below; that is to say, that where the subsidence was too feet, the rise should be $2 + \frac{2}{4} = 2\frac{1}{2}$ feet. It must be understood that the building had not settled equally throughout all its parts. The south end settled but little, while the greatest depression was confined to the middle, west side, and north end, causing a curve sideways in the line of the top of the building, having a versed-sine of twenty-eight inches. The building was constructed of green lumber and timber; it settled and seasoned in this crooked state.

As the partitions of the bins are generally eight inches thick, of plank, and sixty-one feet high, one every twenty feet longitudinally, and one every ten feet transversely throughout, it can be conceived that in raising and giving a new or rather reverse form to the plain of the old foundation, unequal resistance to the action of the screws would result. Such was the fact. Had each screw to exert an equal force, then about six tons would have been the power required of each of the sixteen hundred and fifty (1650) used in raising. When the work of raising commenced, it was soon demonstrated that a force of sometimes nine tons was required to each screw in some of the lowest parts of the building, while at the higher parts comparatively little force was required; in fact, it was necessary in many places to carry the building from four to six inches higher

than intended, to be able to shove under the previously prepared pier caps on piers, twenty to forty feet distant. After all the screws were in place, the work of raising commenced, and after one week's labor, the structure was at the proper height to introduce the stone and iron pier caps. To do this, all timbers and screws had to be removed from the pier in hand. Other than that this process brought a great weight upon the adjoining screws, sometimes stripping them. No difficulty was encountered, of moment, in performing this portion of the work. This part done, the old floor was removed, and timber taken away that was used for the screw foundation, new floor laid at the right height, the fourteen iron hopper tanks raised to a proper height, screws and timbers removed from the outside walls, and the same bricked up under the water-table; seventy feet of the west brick wall which had crushed badly in settling, removed; shafting lined, scales leveled, and the whole building put in complete working order, on the stipulated day, the 20th of August, 1867, and in time for the fall business.

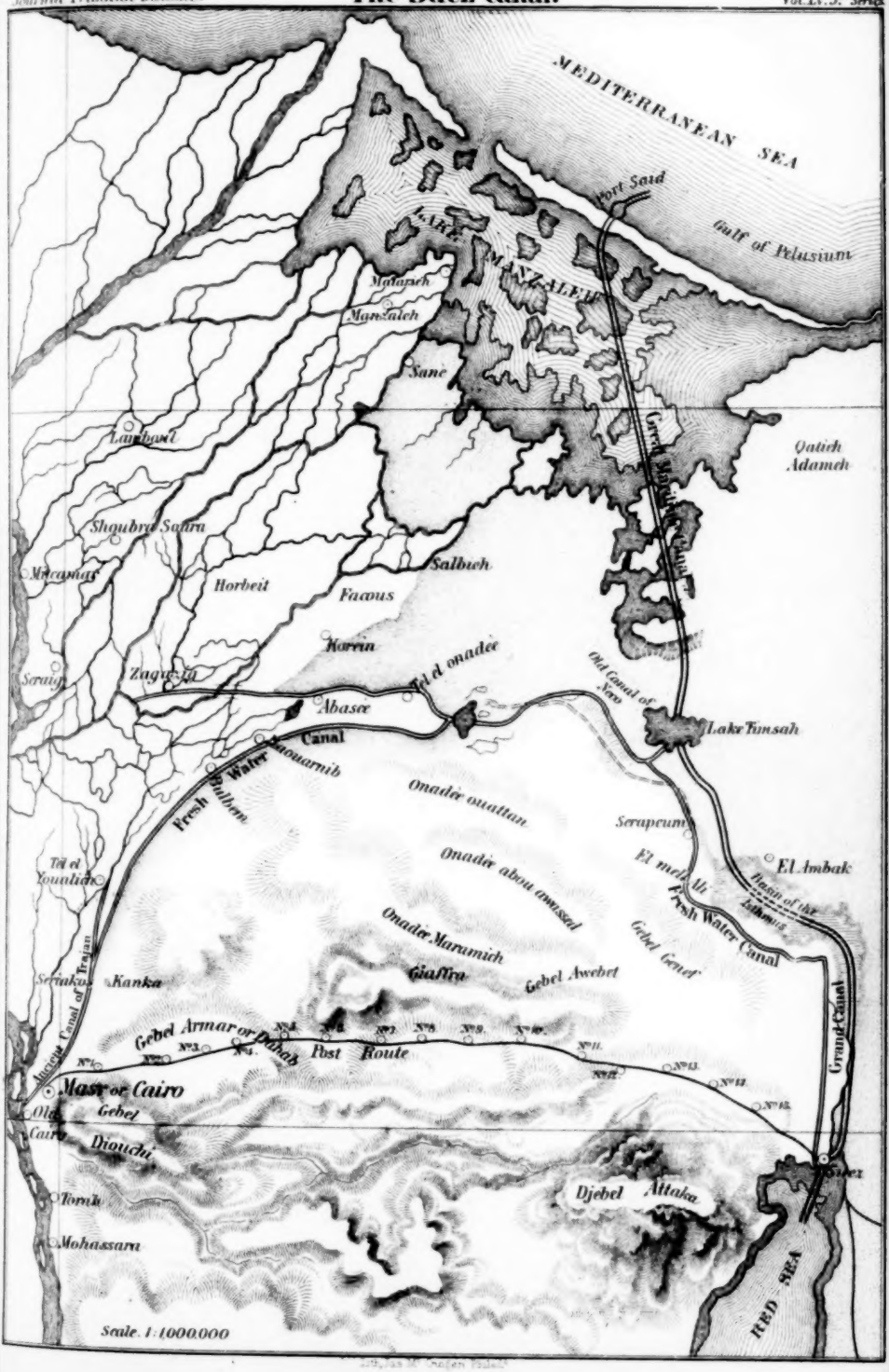
From over one thousand levels taken at different times, extending through a period of twenty-eight months, prior to the raising of the elevator, compared with an average load of 400,000 bushels of wheat, the monthly settlement was found to be ·05855 feet. The building has now been raised six months, and under a similar average load, shows a monthly settlement of ·03477 feet. So that it appears to have decreased from former monthly settlement, two-fifths nearly. There are strong grounds for believing that this monthly rate will rapidly decrease and soon vanish, rendering it unnecessary to raise the structure again.

The average number of men employed upon the work was one hundred and thirty.

Engineers' Office, Milwaukee and St. Paul Railway Co., Milwaukee, Wis., Feb. 28th, 1868.

THE SUEZ CANAL.

In view of the commercial importance of this enterprise, as well as the diplomatic prominence which it has attained of late years, it may be interesting to note the present condition of the work, the prospects of its early completion, and the probabilities of its being maintained as one of the great highways of commerce.


MEDITERRANEAN SEA
Port Said
Gulf of Pelusium
LAKE MENZALEH
Matarieh
Manzaleh
Sane
Lambard
Qatieh
Adamieh
Shoubra
Sanra
Mecanus
Horbeit
Salbuch
Facous
Karrin
Zagazig
Abasse
Canal
Fresh Water
Onadar ouattan
Serapeum
El Ambak
Onadar abou amssed
Onadar Maramich
Ghafira
Gebel Awebet
Gebel Genef
Fresh Water Canal
Kanka
Gebel Armar or Dahab
Post Route
Grand Canal
Mast or Cairo
Gebel
Dioudi
Djebel Attaka
Suez
Tomah
Mohassara
RED SEA
Scale 1:1000000

The facts here presented, were gathered while on an excursion along the line of the proposed canal, in March, 1867.

The present article will merely glance at the history of crossing the Isthmus of Suez by water, dwelling at length upon the actual work now undertaken, and the means employed in its execution.

The traditions of the Arabs, as well as the researches of Champollion and other Egyptian scholars, attribute the cutting of the first canal, which led from the Nile to the Red sea, to Sesostris or Rameses II., who reigned about 1300 B. C.

Pliny and Aristotle also mention Sesostris as the originator of this work. It is quite certain that Neco and Psammeticus, about 600 B. C., re-opened the ancient canal, which had been allowed to become filled with sand in some places.

Ptolemy Philadelphus still further improved the navigation, and added sluices to control the flow of water, which were at the same time made of sufficient capacity to allow vessels to navigate them.

After the conquest of Egypt by Cambyses, Darius came from Persia to take possession of the conquered province, and while there, caused the canal to be re-constructed. Herodotus, writing an hundred years later, gives an account in detail, of his passage through the canal, and mentions the fact that Darius had repaired it.

After the battle of Actium, Cleopatra endeavored to withdraw the Egyptian fleet through the canal to a place of safety in the Red Sea, but was prevented from so doing by the low stage of water in the Nile, at that season.

This circumstance drew the attention of the Roman Emperors, Trajan and Adrian, to the canal, and they caused another branch or feeder to be dug to the main body of the Nile, near to where Cairo now stands. This branch joined the ancient canal at Zagazig, and was continued thence to Suez.

The whole work was again neglected for many years, and was next repaired by order of the Caliph Omar, about A. D., 640. In 780, or thereabout, the Caliph El Munsoor Aboo Grafer caused the canal to be filled up, in order to prevent the export of breadstuffs to the province of Medunch, which was then in revolt.

The Sultan, Hakem, A. D., 1000, is said to have again put the line in navigable order; but certainly for a short time; as the southern or Suez end has long been choked with sand.

The northern or western portion of this ancient canal, from Zagazig to Gassassine, say 22 miles, has always been kept in order, for

the purpose of furnishing water to irrigate a tract of land called "the Ouady," of about 30,000 acres, part of the Scripture "Land of Goshen," and where are now some 20,000 mulberry trees, and excellent cultivation.

The question of direct water communication from the Mediterranean to the Red Sea, has engaged the attention of several of the sultans of Turkey, but they did nothing to promote it.

While in Egypt, in 1798, Napoleon ordered his engineer, Mons. Lepér, to run a line of surveys across the Isthmus, to ascertain if the two seas were on the same level. The order was obeyed, but the work was done hurriedly, with poor instruments, and through the midst of hostile tribes; so that when it was announced that there was a difference of level of nearly thirty-three feet, no one placed any confidence in the report. The mathematicians, Laplace and Fourier, declared that this result was inconsistent with theory, and that there could not be any such great difference, if indeed there was any at all. Subsequent examinations have proved the correctness of their assertions; Mons. Bourdaloue, the eminent French engineer, having ascertained in 1847 that the difference of mean tide in the two seas was only about 6½ inches; the tides in the Mediterranean being from 9 to 12 inches; and in the Red Sea, from 50 to 70 inches.

In the autumn of 1854, Mons. Ferdinand de Lesseps visited Egypt by invitation of Mohammed Said, son of Mehamet Ali, then Viceroy, with the design of discussing the feasibility of constructing a ship canal of large dimensions, running directly from sea to sea. M. de Lesseps had been the French Consul General in Egypt, for the seven years succeeding 1831, and had already given much attention and study to this question, as is well known to the viceroy. The result of this visit was a preliminary concession or grant, in November, 1854, from Mohammed Said, representing the Egyptian government, authorizing M. de Lesseps to form a company for the purpose of digging the canal, and securing to such company the exclusive right of transit for 99 years, from the day when the work was finished.

A new and thorough survey of the isthmus, from Suez to the Bay of Pelusium, was commenced at once, by the engineers of the viceroy, Messrs Linant-Bey and Mougel-Bey, who completed their work in March, 1855. In February of this year, M. de Lesseps went to Constantinople, to obtain the sultan's confirmation of the concession given to him by the viceroy. The sultan and his grand vizier

were most favorably disposed toward the enterprise, but were persuaded to withhold their formal assent thereto, through the influence and representations of Lord Stratford de Redcliff, the English ambassador. This was during the Crimean war, and the Turkish government were afraid of doing anything which might offend so powerful an ally as England.

The detailed plans of the isthmus survey by Linant-Bey and Mougel-Bey were finished in August, 1855, and in the following October were submitted for examination to an international commission of engineers, nominated by the governments of Austria, England, France, Holland, Piedmont, Prussia, and Spain. The commission first met in Paris, and in November five of the members went to Egypt to examine the whole question of the canal in detail, upon the ground. They returned to Europe late in January, 1856, and made their report in December of that year, confirming the feasibility and safety of the enterprise. Notwithstanding the fact that the sultan had declined to confirm the concession of the viceroy, M. de Lesseps succeeded in organizing the canal company, with a capital of two hundred million francs, and obtained a second concession in January, 1856, similar to the first, but much more in detail. The constitution and regulations of the company which was organized under the French law, were also submitted to the viceroy, and approved by him.

This matter of the Suez canal caused a good deal of discussion in the English Parliament, during the summer of 1857, and the spring following. Lord Palmerston opposed it most violently, as being contrary to the policy of the government on the "Eastern question;" at the same time, the commercial community favored the enterprise, on the ground of its facilitating their intercourse with India.

There appeared in the *Edinburgh Review*, for January, 1856, an elaborate article, going to show that the Suez canal could not be constructed; that it could not be maintained, even if it should be built, and that it would be of no benefit to any one, even if constructed and maintained, as a navigable channel for shipping. The *Quarterly Review* followed in the same strain. It was under these discouragements that M. de Lesseps commenced actual work, in 1859, although it was as late as March, 1866, before the final formal consent of the sultan was obtained, which put the matter beyond the reach of all further diplomatic interference.

The line of the ship canal, as determined by the commission of engineers, runs nearly north and south, from Port Said, on the Mediterranean, to Suez, at the head of the Red Sea, a distance of one hundred miles. The width at the water line will be 330 feet, with a uniform depth of 26 feet. The alignment is very favorable, there being but eight curves; the shortest radius is 6666 feet, with an angle of 143°. For nearly three-quarters of the distance, the canal will be dredged through a line of shallow lakes or basins, some of them containing brackish water, filtered in from the sea, and others being dry at present, indicating the locality where lakes existed at some former period. The intervening strips of land, are parts of the great Desert, which extends over so large a portion of Egypt, Syria and Arabia; an arid, desolate, waste, with nothing to sustain either animal or vegetable life. It was, therefore, a matter of the first importance, to introduce a supply of fresh water along the line of the proposed ship canal, to sustain the men employed, as well as to supply the boilers of the necessary steam engines. To accomplish this, the company dug an extension from the terminus of the ancient canal, at Gassassine, to a point on the line of the ship canal, midway between Port Said and Suez. This work was executed under the direction of Mons. Cazean, at an outlay of 700,000 francs; about thirteen hundred thousand cubic yards of earth being moved. The length of this fresh-water canal is 30 miles, the width at the water line 66 feet, depth 6 feet, with a fall of about 2 inches per mile. Its direction is nearly east, coming in at right angles to the line of the main canal at a point now called Ismailia, so named in honor of Ismail Pasha. From here, the water was, at first, distributed to the camps along the line of the ship canal, by transportation on the backs of two thousand camels and half as many donkeys, which were employed for that purpose, for many months. Afterwards a cast iron pipe, 6¼ inches in diameter, was laid from Ismailia to Port Said, a distance of 50 miles, and through this about 22,000 cubic feet of water have since been forced daily. There is now a second pipe laid, parallel with the first, of 10 inches diameter, furnishing about 32,000 cubic feet of water per day, additional. The pumping engine at Ismailia, is a beautiful piece of mechanism, made by Le Banneur & Pétan, Paris, rated at 50 horse-power. It was one time necessary that it should be kept running, night and day, for five consecutive months, and during this period, it was not once stopped. These water pipes are

tapped along the line, at such points as required, to supply the men and engines there at work. The cost of these water-works has been about six million francs. The level of the fresh-water, at Ismailia, is 19 feet above that of the salt water in the canal, and two locks have been constructed, so as to form a navigable connection between them, and of sufficient size to allow the passage of boats 100 feet long and 26 feet wide. At a point on the fresh-water canal, 2½ miles above Ismailia, a branch canal takes off to the southward, extending for 58 miles, to Suez; this line was also constructed under the direction of Mons. Cazean, and cost about three and a half million francs; it was finished in 1863. By this branch fresh water is furnished to the camps and engines south of Ismailia, and also to the town of Suez; whereas, formerly, all drinkable water had been brought from the Nile, at Cairo, a distance of 90 miles, over the railroad. In still earlier days, the dependence was upon the "Wells of Moses," situated on the eastern side of the harbor, and this water, the best to be had, was decidedly brackish. It is by means of this last mentioned branch canal, that water communication has been opened between the two seas, and not through the length of the ship canal proper, as the public have been led to believe. The *northern* end of the ship canal, from Port Said to Ismailia, is, however, now sufficiently advanced to allow the passage of boats drawing five feet of water; and the current from the Mediterranean has been flowing through this portion for a number of months, and is daily filling up the basin of an ancient lake, "Timsah," at the point of junction of the fresh-water canal, from Gassassine to Ismailia, and the ship canal. History and tradition both inform us, that there once existed, at this point, a lake famous for the number of crocodiles to be found in it.* It must have been a fresh-water lake, and been fed by the overflow of the Nile.

The whole extent of the isthmus is covered with marine shells, similar to those which are now found in the neighboring seas, indicating, beyond a doubt, that at no very remote period, geologically speaking, the salt water stood at a higher level than it does to-day; and that the isthmus, as such, did not then exist. There is quite a remarkable depression in this neck of land, as now seen, and through this depression or valley the canal will be constructed. Port Said, at the Mediterranean entrance, is in latitude 31° 16′

*The name "Timsah" in old Arabic, means *Crocodile.*

north, longitude 32° 19′ east. This point was selected for the reason, that just here the line of deep water is nearer to the beach than anywhere else along the coast. In the bay of Pelusium, it was found that the line of 33 feet soundings was nearly 4 miles from the shore, while at Port Said, the distance is only about half as great. The beach in all this region, is merely a narrow strip of sand one hundred or two hundred yards in width, inside this are a number of shallow lakes, or mere salt marshes, some of them of great extent.

(To be continued.)

ANCHOR ICE.

In this *Journal*, Vol. 51, p. 327, was published an account of the formation of ice on a strainer connected with the inlet pipe of the Detroit Water Works, and at a depth of 25 feet, together with the opinion of Professor S. H. Douglass of the University of Michigan. In the following volume 52, p. 101, appeared, with editorial endorsement, the reply of Professor Douglass to objections which had been urged by Professor Henry, against his explanation. On page 236, of the same volume, we find an excellent paper, by J. B. Francis, C. E, confirming the views of Professor Henry. Having thus referred to the history of the subject, as far as this *Journal* is concerned, we will briefly record the results of sundry experiments, which have been made at the Detroit Water Works, upon the strainer in question, and fully establish the true theory and explanation of the action. This record we take from the Report of the Board of Water Commissioners of the above place. After a description of the strainer, which is of so simple a description that it need not be here repeated, we find as follows:

"Under certain circumstances, during extreme cold weather, it is with difficulty a supply of water can be obtained, in consequence of the accumulation of ice on the strainer, frequently requiring the speed of the engine to be reduced, and at times to stop it for several hours together, no water passing through the pipe into the well, notwithstanding the bottom of the well is twelve feet below the surface of the river. The size of the well is about forty feet long, eighteen feet wide, and twelve feet deep. The circumstances under which the difficulty occurs are, when the weather is cold, and ice is

forming in the lake above, and on the shores of the river, and the river is free from ice over the strainer. But when the river is covered with ice over the strainer, the difficulty does not occur at any degree of cold.

This fact induced us to suspend a line of booms from the wharf some distance above and outside the strainer, so as to retain a covering of ice over it when the rest of the river was not covered. This boom was successfully kept in position until the ice firmly formed inside of it, but failed to accomplish the object. The theory that the covering of the entire surface of the river by ice prevented radiation, and by that means the ice did not form on the strainer, was strongly urged; and, if so, any covering over the strainer would answer the same purpose. To test it, we, last summer, employed the submarine divers, Messrs. Harrington and Philips, to build a submerged platform of planks immediately over the strainer, which they successfully accomplished, but which, however, proved of no avail, for the stoppages occurred at a higher temperature than before.

On the 29th of December last, while but a small supply of water could be produced, we induced Mr. Harrington to go down to the strainer and make an examination of its condition. Owing to the extreme coldness of the water and atmosphere (the thermometer on the wharf marking twenty-six degrees), it was impossible for him to remain down beyond a short time, but this was long enough to discover the fact that the strainer, with its surrounding spiles, was one mass of ice, particles collected into a mound some ten feet high, and about fifteen feet in diameter, and that large quantities of minute crystals of ice were rapidly passing and adding to the mass already collected. Specimens of the ice were brought to the surface in a bag. It was in sheets and particles thin as paper, translucent, with sharp, pointed edges. A further examination developed the fact that the small amount of water the pump was then receiving came through the lower or down-stream side of the strainer, this being the only point where he could approach it, and which was found but slightly covered with ice. When these facts were ascertained, we thought we were about to solve the problem and provide a remedy for the difficulty, especially as a similar experiment to the one we then proposed to adopt had been successful at the Buffalo Water Works. It was to inclose the strainer, except a part of the down-stream side, so as to prevent these floating particles from col-

lecting on and around it. To do this, a large piece of canvas was prepared of suitable size, and firmly fastened by the diver around the spiles, which, with the platform, completely covered and encircled the strainer, except on the down-stream side. This was but just completed when the weather became colder, and during the night the thermometer indicated several degrees below the freezing point, and before daylight the engine stopped for want of water. Preparations were made as speedily as possible, for another descent to the strainer. At 11½ o'clock, A. M., the diver went down, and this very important fact was ascertained, that, with the temperature of the atmosphere at twenty-nine degrees, the water at the surface was thirty-three degrees, whilst at the bottom of the river it was thirty-five degrees. At this descent much less ice was found on the strainer and its surroundings, than the first time. The lower side was clear, but on the upper side the action of the current had worn the ice into elongated cones, pointing up stream. At this time the pump was receiving a full supply of water. About three hours later, the diver again descended (thermometer thirty-three degrees); he found the ice had entirely disappeared. The wooden platform was removed, since which time no trouble was experienced up to the evening of the 24th inst., when the surface ice of the river was in motion. From 1 o'clock, A. M., of the 25th inst. (thermometer sixteen degrees), no water could be obtained until daylight, when the engine was again started, and no further delays have since occurred.

Your committee, by the aid of the submarine diver, have ascertained the fact that at certain temperatures these ice particles are ever present in the river, and are continually passing down by the action of the current, and whatever obstructions they meet with in their passage they collect upon. This being the case, we recommend, the coming summer, the entire removal of all spiles and other substances adjacent to the strainer, believing that with nothing but the smooth dome of the strainer for these particles to lodge upon, the quantity that will accumulate cannot very seriously prevent the flow of water to the inlet pipe."

The report from which the above extracts are made, is signed

S. G. Wight,
J. Owen,
Committee on Supply of Water.

THE LOUISVILLE BRIDGE.

As long ago as 1829, a charter was granted by the legislature of Kentucky, for the construction of a bridge over the Ohio River at Louisville. Operations were commenced, but were shortly after abandoned for want of capital.

In 1856 a new charter was granted, and under this charter the Louisville Bridge Company was organized.

The first stone was laid by Messrs. Nash, Flannery & Co., the contractors for masonry, on the first day of August, 1867, and since that time the work has progressed favorably. Owing to the extraordinary season of low water during the past summer and fall, the piers were put in at a much less expense than was anticipated.

The contract agreed that the work should be completed by the first of September, 1869. The company, however, having offered a liberal bonus for the completion of the work before the time specified, we see no reason why it should not be accomplished. The estimated cost of the bridge is $1,500,000, which does not include the right of way and depot grounds, which latter may be estimated at $100,000; total cost, $1,600,000. The expenditure thus far amounts to $160,203.85.

Two plans of construction were submitted to the Board of Directors; one contemplating the construction of the bridge merely for railroad purposes, the other for the use of vehicles of all descriptions, including street cars; the latter plan was the one adopted. The following are the general features of this plan:

The grade of the road approaching the bridge on the Kentucky side, corresponds with the grade at the point of crossing High Street, from which place it ascends at the rate of eighty-two feet per mile, striking the first span of the bridge at an elevation of sixty-one feet above low water, and continuing at the same rate until it reaches an elevation of ninety-five feet above low water in the middle chute.

From this point the grade of the bridge is level for a distance of 2,213 feet, at a level of 101½ feet above low water. The grade then descends at the rate of $78\frac{8}{10}$ feet per mile, reaching the northern abutment at an elevation of thirty-five feet over the surface of the ground.

The grade of the approaches continues to descend until it strikes the surface of the ground. The superstructure will be placed below the grade of the road, except where it crosses the middle and Indiana chute. The lowest point of the superstructure over the middle chute, is 102½ feet above low water, and over the Indiana chute, 96½ feet; the low water in the Indiana chute being six and a half feet lower than in the middle chute. A draw-bridge of 114½ feet clear span on each side of the pivot pier, will be built over the canal. The entire length of the superstructure is 5,280 feet; the longest span is that over the middle chute, which is 370 feet. A peculiar feature consists in the fact that the railroad track is to be laid in the centre, the two street tracks on either side; one rail of the railroad track, in addition to another rail on either side, will form the two street railroad tracks.

No street cars or other vehicles can cross at the same time as a locomotive, but street cars and common carriages can pass each other at any place on the bridge.

The time occupied in crossing over the bridge by a locomotive and train, will be about five minutes. At present the Jeffersonville Railroad runs daily, six trains each way over their road, and will, therefore, occupy the bridge for one hour in twenty-four. Of these, seven trains will cross over the bridge during the hours of 6 A. M. and 8 P. M., leaving, therefore, the use of the bridge for thirteen hours and twenty-five minutes unobstructed to the crossing of street cars and wagons.

The superstructure of this bridge will consist of Fink's patent suspension trusses, except the channel spans, which are to be of the triangular plan, arranged by the same gentleman.

WOODEN PAVEMENTS.

Reply and Report of CHAS. H. HASWELL, to a communication from a number of Tax-payers of the City of New York.

NEW YORK, *February* 21*st*, 1868.

GENTLEMEN,—Your letter of the 13th inst., regarding Wooden Street Pavements, is received and considered, and in reply thereto, I submit as follows:

The only wooden pavements now before the public for competi-

tion, that I have investigated, are those of Mr. Nicholson and Mr. C. Williams.

That of Mr. Nicholson is constructed of white pine blocks three inches in width, six inches in depth, and of lengths varying from six to twelve inches, set transversely to the line of travel upon them, with an intervening space or fissure between their transverse courses, which is defined by a strip of wood laid at the base of the blocks; the whole resting upon a layer of white pine boards over an ordinary sand-bed; and for the purpose of attaining durability of the wood, as alleged, its surface is coated but very imperfectly, with coal-tar.

That of Mr. Williams is constructed of yellow pine blocks twelve inches square by six inches in depth, set directly in connection with each other, and resting upon a concrete of rubble and asphaltum, with grooves at proper intervals upon the face of the blocks, running transversely to the line of travel. The direct connection of one block with another, affords support to resist the lateral stress of travel, and the concrete gives support to the blocks in their resistance to a vertical stress.

To meet the requirements of endurance to wear and resistance to decay, it is purposed to fill the pores of the wood with an oleaginous fluid, of such consistency as will retain its condition, and thereby not only preserve the wood from decay, but give such support to its fibres as will essentially add resistance to the crushing stress of loaded vehicles. This fluid is condensed from a vapor at high temperature, whereby the watery particles of the wood are dispelled, and the albumen solidified.

Wood in its ordinary conditions, when used for pavements, is subjected to decay and the destruction of its fibres, by the crushing effects of loaded vehicles and horses.

In the former case, if the wood is seasoned, it is subject to *common rot*, from its alternate exposure to moisture and dryness, and if it is unseasoned, it is subject to *dry rot*, by the putrefaction of its vegetable albumen and fermentable elements, as well as to the effect consequent upon its alternate exposure to moisture and dryness.

Wood is altogether too porous in its structure, for endurance to the wear of loaded vehicles, and by the crushing of its fibres it is rendered liable to decay; for if it is seasoned, the abrasion of its surface and the imperfection of the coating, given it by Mr. Nicholson, exposes it to alterations of moisture and dryness, and if it is

unseasoned, the coating of its surface with coal-tar or any like substance, by retaining the fluids, hasten its decay. There is a common but fallacious idea, that the charring of unseasoned timber, as is practised in setting fence posts, preserves it: on the contrary, the painting, coating or charring of unseasoned timber hastens its decay.

Reviewing, then, the elements presented, I am of the opinion—

1st. That wood in its ordinary condition, is unsuited as a material of pavement.

2d. That the wooden pavement now being laid in this city, will not meet the public demands in relation to its economy of maintenance and endurance to wear.

3d. That white pine or any other wood of like porous structure, is altogether unsuited for the requirements of a wooden pavement, unless its contained albumen has been solidified, its fluids expelled, and its pores filled with an antiseptic or oleaginous liquid of such consistency as will retain its condition.

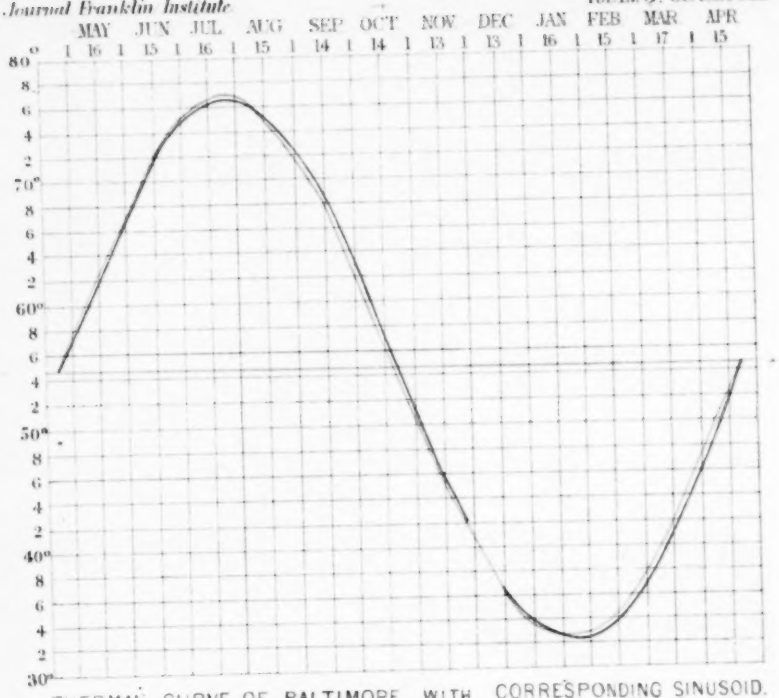
4th. The immediate connection and consequent lateral support of one block with another, in the plan submitted by Mr. Williams, added to the great extent of the bottom surface, resting upon a bed of concrete, will ensure all the stability that it is practicable to give such a structure, within a practicable cost, and that the treatment for preservation as proposed by him, will ensure that endurance of the wood which the requirements of the case render imperative, in cost of maintenance, resistance to wear, and the sanitary condition of the city.

Finally, so imperative are the requirements of durability even in woods exposed in a less manner than in street pavements, that talents and attainments of the highest order have been taxed to meet them, as developed in the essays of Ryan, Burnett, Boucheri, Bethel and Robbins.

I am, respectfully,

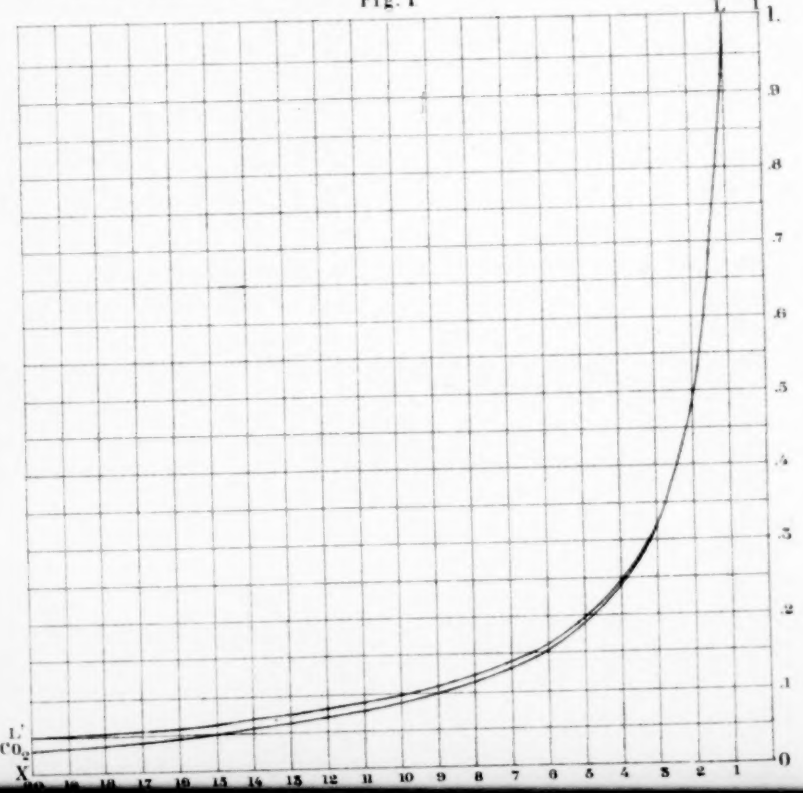
Yours, &c.,

CHAS. H. HASWELL.



THERMAL CURVE OF BALTIMORE WITH CORRESPONDING SINUSOID.

Fig. 1



Mechanics, Physics and Chemistry.

LECTURE-NOTES ON PHYSICS.

By Prof. Alfred M. Mayer, Ph.D.

(Continued from page 196.)

§ IV. *Manners of Expressing a Law—Law evolved from the numerical results of Observations and Experiments.*

The first step in that investigation, which has for its object the discovery of the law of a class of facts, is the minute examination and description of the phenomena and of the circumstances which accompany them, and the determination of those conditions necessary for their production. This having been accomplished, we observe that there always exists between the different circumstances of an associated class of facts, relations or dependencies which bind them together in such a manner, that if we change one of the circumstances of the phenomenon, the others experience determinate modifications.

For example. In the compression of air, we have seen that the smaller the volume into which the air is forced, the greater the force of compression required; and on further examination with *measurements* taken of (1) the volumes occupied (2) under different pressures, we find that the relation which binds (1) and (2) is that *the volumes of the air are inversely as the pressures to which it is subjected.*

Such an expression of the relation existing between the different circumstances of a class of associated facts is, as we have seen, (§ I.) *a physical law.*

"These laws rule all phenomena, and are their most complete representation. Their existence did not escape the acute minds of the philosophers of antiquity. Plato, questioned concerning the occupations of the Deity, replied that *He geometrized without ceasing;* wishing thereby to express according to Montucla, that the universe is governed by geometrical laws" (Daguin's Traite de Physique, Vol. I., p. 8).

If the law is the expression of a general *quantitative relation* existing between the associated facts of the phenomenon, it can be

replaced by a line referred to coördinate axes, as in the method of Analytical Geometry.

Example 1. Thus, *a Parabola* represents the law of falling bodies, because the origin of rectangular coördinates being at the principal vertex, the abscissas are to each other as the squares of their corresponding ordinates; or,

$$x' : x'' :: y'^2 : y''^2;$$

and the law of falling bodies is that *the spaces fallen through are as the squares of the times;* therefore, if any ordinate represent in units of length the units (seconds) of time occupied in the fall, the units of length contained in its corresponding abscissa will give the units of length fallen through; one unit of length in this case—being a function of the intensity of gravity—is, for the latitude of New York, equal to 16 feet 1 inch.

The above is directly shown in MORIN'S MACHINE, where the body describes the parabola by falling parallel to the axis of a uniformly revolving cylinder, against which a pencil, attached to the falling body, gently presses. The curve thus formed is found on spreading out the paper, which covers the cylinder, and measuring its abscissas and ordinates, to be a parabola. Thus, in this beautiful experiment, the body itself writes on the paper the law of its motion.

Example 2. The law of the compression of gases is given by a curved line (see Fig. 1, Plate III. Curve L L'), whose abscissas representing pressures and ordinates volumes, has for its equation

$$y = \frac{1}{x}$$

This curve is an equilateral hyperbola, and therefore the axes of X and of Y are asymptotes to the curve; and this should be so, for the gas, supposed to be non-liquifiable, has under an infinitely great pressure, still a definite volume, which is expressed by the ordinates corresponding to that pressure. If, however, the gas is not permanent (like carbonic acid), the curve will cut the axis of X at a point corresponding to the pressure producing liquifaction. If all those gases which are susceptible of liquifaction—though the pressures required for this result for certain gases might be beyond the limit of practicable experiments—had curves whose deflections towards

the axis of X all followed the same law, we could, by projecting the curve of any gas, as far as the limit of experiment, determine at what point it would cut the axis of X, and thus determine the pressure of liquifaction.

See Fig. 1, Plate III. The curve L L′ represents Mariotte's law, that the volumes of gases are the reciprocals of the pressures; while L CO_2 shows the fraction of a unit of volume, measured on the axis O Y, occupied by carbonic acid gas under pressures, from 1 up to 20 atmospheres, measured on the axis O X. If the curve of hydrogen were projected on this diagram, it would sweep above L L′, departing very slightly from this line on the side opposite the curve, L CO_2.

The advantage of the graphic method of expressing a law is, that it represents *to the eye* the *continuous* relation between the associated facts of the phenomenon, and therefore gives, by direct measurement, the quantity answering to any measure taken of either of the related magnitudes embraced in the projected curve. Also, by the mathematical discussion of the curve, new relations which otherwise might pass unknown, may be evolved.

Sometimes the relation existing between the associated facts is too complicated to be susceptible of a concise quantitative statement. In that case, we lay off on an axis of rectangular coördinates lengths of abscissas equal to various values of one of the quantities, and on their corresponding ordinates lengths equal to the corresponding values of the other quantity. We then draw *libera manû*, through the several points thus determined, a curved line, and this line will be the *continuous expression* of the relation existing between the two quantities considered.

It may happen that the inspection of the curve leads to the discovery of a law, which we could not have made from the direct comparison of the numbers given by experiment or observation. For example, if the curve was one of those lines studied by geometers, and whose properties are well known, the relation which exists between the abscissas and ordinates of the curve, or, in other words, its equation (referred to the axes X and Y), will express the law which we seek. If, therefore, we recognize by mere inspection, that the curve resembles a known line, we must proceed in the following manner to the verification of that supposition. We write the general equation of the curve, referred to the axes X and Y, giving it indeterminate co-efficients; we then successively substitute in that equation as many values of x and of their corresponding ordinates y, as there are co-efficients; which gives *equations of condition*, by

means of which we calculate the values of these co-efficients, which we then substitute in the general equation. We then successively substitute for x and y other numerical values given by the experiments or observations, and we examine if these numbers satisfy the equation. If this is the case, we conclude that the curve is really the one we suspected, and its equation expresses the mathematical law of the phenomena.

For a simple example, take the curve described by Morin's Machine for showing the law of falling bodies. If, from preliminary measurements, we suspect the curve to be a parabola, we have, for the general equation of that curve—

$$y^2 = 2\,p\,x;$$

in which, placing x' and y' from measured coördinates of the curve, we have—

$$2\,p = \frac{y'^2}{x'}$$

substituting this value of the parameter in the general equation, and making x and y successively x'' y'', and x''', y''', &c., obtained from other measurements on the curve, we find that—

$$y''^2 = 2\,p\,x''; \quad y'''^2 = 2\,p\,x''', \text{ \&c.}$$

whence we conclude that the curve is the quadratic parabola, and therefore—

$$x' : x'' :: y'^2 : y''^2;$$

and since in the curve described by this machine, x' and x'' are equal to the spaces fallen through by the body in the corresponding times y' and y'', we have the law that *the spaces fallen through are as the squares of the times.*

Example, in which more complex relations exist—

We have (in a paper preparing for publication), projected the thermal curves, of the variation of temperature from day to day throughout the year, of fifteen places, differing in latitude, longitude, elevation above and distance from the sea, and in other topographical features; and on discussing these curves, we find that they can all be replaced by *sinusoids*, differing from each other only in the amplitude of their flexures, which corresponds to half the annual range of temperature of the different stations.

Lengths of abscissas standing for days and lengths of ordinates representing degrees of temperature (see Plate III., Thermal Curve of Baltimore, with corresponding sinusoid; where the horizontal red line marks the mean annual temperature, while the curved red line is the annual thermal variation, and the curved black line its corresponding sinusoid), we obtain a series of points, by laying off on ordinates erected from abscissas corresponding to certain days, the mean temperatures of those days, and then drawing a curved line through these points, we have the annual thermal curve. This curve has its origin at the point of the axis of X which corresponds, in the average, to the date of the 21st of April; the mean temperature of that day being the mean temperature of the year.

(Diagrams of thermal curves, with corresponding sinusoids of fifteen stations exhibited.)

Now projecting on the line of mean annual temperature of each curve, as the base, *a sinusoid* the length of whose base ($=360°$) equals the length of the year; whose point of origin is on the base at the point corresponding to the 21st of April, and whose amplitude equals the half yearly range of temperature, we have, in every instance, so close a coincidence between the thermal curve and the sinusoid, that we can confidently say, that the variation of temperature throughout the year follows the variation of the sinusoid curve.

The equation of the sinusoid is—

$$y = sin.\ x;$$

and as the sines of the first and second quadrants are + and of the third and fourth —, it follows that this is a recurring curve, and up to *sin.* ($x = 180°$) the flexure is above the base line, while from *sin.* ($x = 180°$) up to *sin.* ($x = 360°$) the curve lies below the line, and so on; each succeeding 180° being on the opposite side of the line of mean temperature from the preceding.

Therefore, expressing any date in days reckoned from April 21st, and converting these days into lengths of arc $= x$ at the rate of one day $= \frac{360°}{365} = 0° 59' 1''$, and making the sin. 90° or R $= \frac{1}{2}$ the mean yearly range of temperature, we can readily determine the mean temperature of any date of the year.

1. *Problem.* What is the mean temperature of the 10th of June, at Paris?

The mean annual temp. from 46 years observations,	$= 51.^{\circ}3$ Fah.
Half the yearly range, ...	$= 15.^{\circ}47$
Days from 21st April to 10th June, . . .	$= 50$ days.
The above number of days in arc, . . .	$= 49^{\circ}\ 10'\ 50''$
Natural sine of above arc, ...	$= .756773$
Radius in this example, ...	$= 15\ 47$
Then the temperature of 15th June equals	
$.756773 \times 15^{\circ}.47 + 51^{\circ}.3$	$= 62^{\circ}.90$
Mean temperature of 15th June, from observations of 46 years, ...	$= 62^{\circ}.99$
Difference, . .	$= 0^{\circ}.09$

2. *Problem.* What is the mean temperature of the 13th of Dec. at Baltimore? The temperature from *observations* = 35°·6. Data for solution. From 35 years observations, the mean annual temperature = 54°·4. The yearly range = 44°·4.

3. *Problem.* Calculate the mean temperature at Baltimore, of of the 14th October. The observed mean temperature of this day is equal to 56°·5.

4. *Problem.* Determine which is the warmest and which is the coldest day in the year at St. Petersburg. Data for the solution. Mean temperature, 38°·75. Annual range, 50°.

From observations of 30 years, the warmest day at St. Petersburg is on the average, the 25th July; the coldest, the 19th January.

We can therefore determine the mean temperature of any day of the year for any station (not situate in the tropics), whose mean temperature and yearly range of temperature are known. The mean temperature of any place can be found by taking the temperature once a month during one year, of any spring which issues from a depth of a few feet below the surface of the ground. Thus, the temperature of a spring in Baltimore, from the mean of one observation a month, during one year, was 54°·25, only 0°·15 below the mean given by 35 years observations of the thermometer in the air.

If a law could be established connecting different parallels of latitude with the yearly range of temperature, we could arrive at the other datum, and then the curve of annual variation could be projected from a knowledge of the latitude and longitude, with the determination of the mean temperature of a spring.

This method of representing to the eye, by means of curved lines, the nature of the laws concealed within a mass of numbers, presents the advantage of representing the continuous and periodical nature of cosmical action. It also presents to the eye *a form*, easy to seize and remember, instead of an abstract statement referring to relations of quantities, difficult to be conceived and sometimes impossible otherwise to discover. Thus the thermal curve of Berlin is the graphic expression of the relation of the 365 days of the year to observations made three times a day for 110 years, or, to 120,450 separate numerical quantities.

The curves show by their deformities, either that our data are not the results of sufficiently extended observations to give, by their projection, the expression of a law, or, that another cause is acting which increases or diminishes the effect due to the cause whose rule of action is expressed, in the main, by the curve.

Thus, in the thermal curves of Greenwich, of Paris and of Rome, an upward deflection exists, from the middle of January to the middle of April, causing a departure of about 2° Fahr. from the sinusoidal curves. This departure, at first sight, would appear as opposed to the assumption that the annual variation of temperature follows the variation of the sinusoid; but, in reality, it is "an exception which proves the law;" for it is found that during those months the prevailing winds for those stations are W. S. W., and Dove has conclusively shown that in the northern hemisphere, the thermometer stands highest, on an average, with a S. W. wind. This deflection, however, does not occur in the curve of Berlin, and there a S. 17° W. wind prevals during those months. But this is easily accounted for, and the explanation will at the same time give a sufficient reason for the upward deflection of 2° in the thermal curves of Greenwich, Paris and Rome.

The prevailing wind of Greenwich from the middle of January to the middle of April, reaches that station after having traversed the Atlantic ocean, whose surface water has, during the above months, even in the latitude of the English Channel, an average temperature of 52° Fahr. Now, one cubic foot of water in cooling 1° Fahr. will give out heat sufficient to raise 3080 cubic feet of air 1° Fahr., and the wind after traversing this surface of a liquid, of high specific heat, 13°·5 above the mean temperature of the air during February, passes over only about 85 miles of lowlands before reaching Greenwich. The same prevailing wind reaches Paris after hav-

ing also passed over the Atlantic,—of even a slightly higher temperature than in the case of the Greenwich wind,—and traversed about 250 miles of land-surface not likely to affect its temperature, since this very land has received its thermal condition mainly from the supernatant air; but the S. 17° W. wind reaches Berlin after having crossed the snow covered summits of the Appenines and Alps, and 750 miles of land.

This general graphic method of expressing the relation which pervades a class of facts, evidently gives a ready means for *interpolation*, and even where *deformities* exist, a mean or true curve can be obtained by *sweeping* a line through the mean position of the irregularly placed points given by the observations or experiments. By this last method, Sir John Herschel determined the orbits of several of the double stars (*Transactions of the Royal Astronomical Society*, Vol. V., 1832), and M. Regnault (*Mémoirs de l'Institut*, *t.* 21, 1847, page 316, *et seq.*, and page 574, *et seq.*), from his measures of the tension of vapor of water corresponding to different temperatures, succeeded in ascertaining the extreme oscillations of the errors of those measures, by drawing a mean curve through the sphere of the points given by his experiments. He then substituted this curve for the numbers directly determined by experiment, because this curve expressed the relations of those numbers practically corrected of their errors.

It should be remembered that each number at which we finally arrive, before we place it down as a point to serve in the projection of the curve, is *the most probable mean* which we can obtain from the discussion of the numbers from which it is derived, (see § III.), and that each of these points so determined is arrived at independendently of any other point, and therefore the graphic method is especially adapted to combine all of these independent determination of points in one curve, and to make them mutually correct each others errors.

The curve thus obtained can be rendered more serviceable in practice, by obtaining from it, if possible, an equation which will express it; but if we find that it cannot be expressed by a single equation, we can, by the aid of *formulæ* of *interpolation*, find the value of each ordinate corresponding to as small an increase in each successive abscissa as we desire. We should not, however, apply a formula of interpolation to the numbers before we have obtained from them a mean curve. The interpolation is merely used to give

a ready means of obtaining the values of any related magnitudes expressed by a curve, which shows the relations of the numbers corrected of their errors; for, as M. Regnault remarks, "the graphic method when it is properly executed, is preferable to all methods of interpolation by calculation; it permits us to distinguish, immediately, the variations due to the accidental errors of the observations, and the constant errors which depend on the diversity of the methods which we have employed."

(To be continued.)

THE AIR-TIGHT GALVANIC BATTERY.

By Chas. T. Chester, Esq.

The galvanic battery serves many important purposes, which no other apparatus properly supplies. But the use of acids, with the destruction of material that they occasion, the space occupied, the expense and trouble attending their care, have prevented many from using any combination for producing dynamical currents of great intensity. Induction currents from coils of wire and magnets have formed a convenient substitute for those generated by the acid batteries, but it is becoming recognized that these induction currents will not produce the same effects as those from batteries, and especially for electro-therapeutics, an effort is being made to produce a battery of long endurance, and requiring little care. In Europe, wherever the teachings of Remak and his followers have prevailed over those of Duchenne, the great advocate of the Faradaic (or induction) currents, much attention has been given to the production of a good galvanic battery, easy in management, and not too self destructive. The ingenious manufacturers of France and Germany have made several useful batteries, but all of them of considerable size, and not portable. The principle aimed at has been, in almost all cases, to place certain plates and chemicals together, but also so to manage the diaphragm that chemical action is controlled. The stronger or denser the diaphragm, the slower is chemical and electrical action. Most of these combinations have been modifications of the sulphate of copper battery of Daniell. The battery of Stohrer is made up of more energetic elements, viz: zinc, carbon, and chromic acid. These, when immersed in an acid, both form a very self-de-

structive combination. So it is arranged that the carbons shall be raised at pleasure out of the glasses, and to effect this easily, the usual porous cell is omitted, and a hole in the carbon cylinder receives the chromic acid. Practically, this beautiful arrangement gives much trouble, and in all of these batteries the waste of material is not due to the useful currents drawn out on medical practice, but to self-destruction in the elements. We think that we shall show that as far as medical electricity is concerned, we need not resort to batteries of great plate surface and "quantity" power, and there are other uses for which small batteries of great intensity may prove quite as powerful as those of much greater size, as for instance, the testing of long telegraph lines and delicate instruments in many electrical researches, and in the ignition of blasts in mining and excavations. For this last purpose, magneto-electrical machines have been provided, which give sufficient quantity and intensity to fire a large number of fuses at one time, by the ignition of an exceedingly attenuated conductor, like the mark of a lead-pencil. The force of these machines has to be nicely adjusted to secure precision in blasting, and a small battery of adjustable force would be an excellent substitute. For all these purposes, a battery requires to be used only a short time at once. We wish, therefore, to find some arrangement that will give currents of sufficient quantity, adjustable, however, to our requirements, also capable of a very high intensity, but also adjustable; it must be brought into action speedily. It must remain out of action indefinitely, without loss of power. It must be portable, clean, and not too expensive.

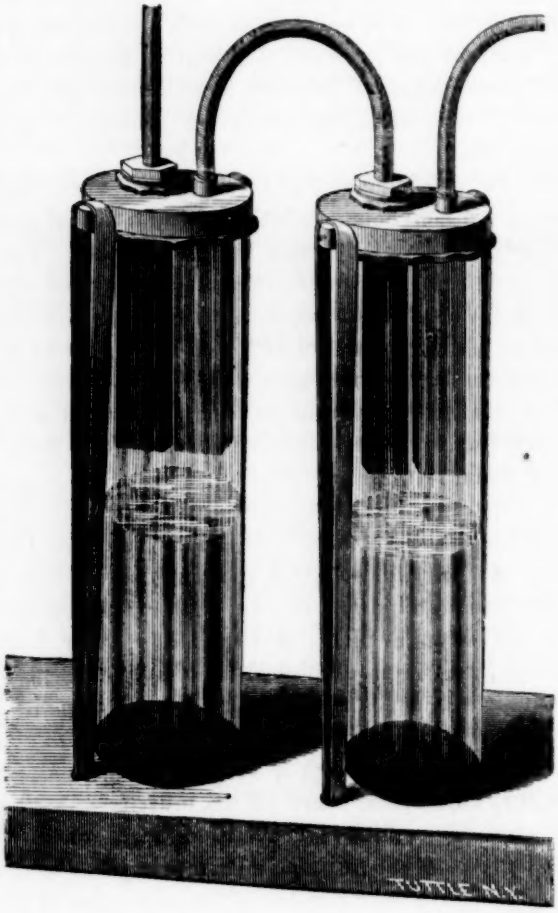
In the attempt to produce such an instrument, a number of questions must be solved. First: What amount of battery "quantity" is necessary for currents through the body, or similar resisting media, such as long telegraph circuits? Secondly: Can we find any combination of elements in a very small space that will give us this force? Third: Can we dispense with acid? Fourth: Can we absolutely remove the elements from the exciting fluid when the battery is not in use? Fifth: Can we prevent evaporation and the generation of gas? Sixth: Can these other requirements be made consistent with simplicity of structure and great ease in renewal?

In answer to the first, we have testimony extending through two or three years. In the Journal of *Psycological Medicine*, July, 1867, we have an account of a voltaic pile, consisting of perforated zinc and brass wire gauze, excited by cloth moistened in acetic acid.

These plates were about two inches square, and numerous. During two or three years use, it had touched certain cases in which the induction currents commonly used, had no effect whatever, muscular contractions taking place instantly with the pile, but not with the inductive apparatus. In other hands, similar effects were produced. Paralysis yielded to these galvanic currents. The piles would produce, when their current was broken rapidly, shocks similar to those from inductive apparatus, but superadded and accompanying these evidences of currents of high tension, an appreciable "quantity" current was present. A sensation may be produced by a current of exceeding small quantity, as will be shown, but a degree of "quantity" higher than that produced by coils is necessary in many medical cases.

The piles, though efficient, are practically very troublesome and uncertain. A convenient substitute would be valuable, whose "quantity" current at least equals that of the pile. The battery we propose to describe, is capable of giving a range of effects from 256 down to 0. We will describe, without entering into detail, some experiments made in comparison with well known forms of battery, and we will term "electro-motive force" the power exerted to move certain magnetic instruments. In its highest activity, one cell of the new battery gave a force equal to that of a Smee battery, exposing 16 square inches of zinc surface; when nearly spent, the force equalled that of the same Smee battery, exposing $\frac{1}{4}$ inch surface. The range is here from 1 to 256. To equal the force 1, fifteen plates of the pile, soldered together for surface, were required. The greatest power of the battery therefore exceeds that of one set of pile plates 3840 times. Now batteries of different kinds have been employed to drive currents through the body, having ten times the quantity of the 16-inch Smee, and thus a force 38,400 times greater than that of the pile has been attempted to be passed through a very resisting medium, and it would seem that curative or other effects must be enhanced, if the attempt be successful. How much "quantity" current can pass through the body or other resisting media, is a question of interest. We can easily ascertain the "resistance" to conduction of the human body, by moistening the hands, and grasping electrodes. We find that the "resistance" equals almost 550 miles of telegraph iron wire. It is well known that we cannot cause "quantity" currents to pass through this length of conductor. It requires much intensity to pro-

duce magnetic and other effects, and quite delicate instruments to indicate it. We may use a battery, which, with short conductors, acting directly upon a magnet, would raise 500 pounds; and this same battery, interposing the body in the circuit, would have no apparent influence upon the same magnet. But to measure more exactly the effect of this resistance, and having a battery capable of so great a range of force, and giving the conductibility of the body

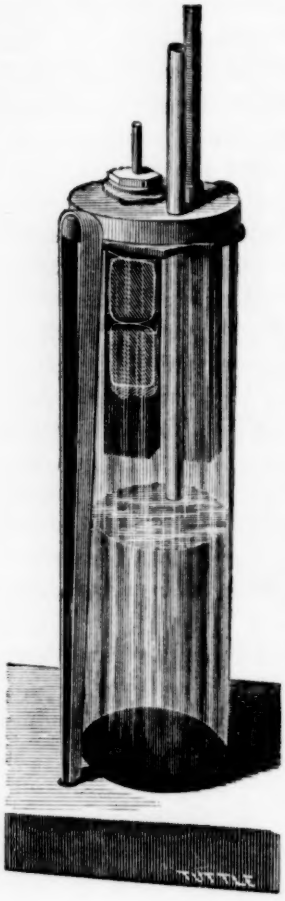


the fairest chance, by the employment of large moistened electrodes, we measure different effects upon a galvanometer of fine wire. Our battery is made capable of its quantity range from 1 to 256, and in

intensity from 1 to 150. With the intensity of 1, almost any quantity power will drive the needle to 90°. Through the body no effect is perceptible. We now increase the intensity, until the current passing through the body, drives the needle to 27°. The intensity being the same, we increase the "quantity" from 1 to say 25. The needle advances to 37°. We now use the same intensity, and give the battery a quantity of 256, and the needles sluggishly advance to 47°. Thus, with an increase of quantity power from 1 to 256, we have only slightly increased the effects of the current. The inference is unavoidable. The body refuses to carry these currents, and all other highly resisting conductors follow the same law; and so, for many purposes, we are employing a force vastly in excess of our necessities, and we waste in self-destroying combinations for dynamical electricity, fifty times as much as we make good use of. At the same time, many useful purposes can be served only by the actual use of very great and continued force, and here the small battery exhibited in the engraving would be entirely out of place. A description of it, and the mode of using it, as well as what has been done with it, will prove, however, that it is possible to secure the results we aimed at, as far as regards cleanliness, portability, power, with extreme range of adjustment, freedom from consumption when not in use, and ease in renewal.

The engravings represent glass cells, three inches long, and one inch in diameter, inserted in a wooden block; a zinc cover is provided for each glass, and a projection from this zinc cover, running down into the glass, forms the zinc element. The other element is carbon, carefully connected with platinum, and well insulated from the zinc cover. This cover has a plate of soft rubber interposed between it and the glass top, and the packing is made completely air-tight and water-tight, by the pressure of two rubber springs pulling the cover firmly down. Connection from one cell to the next is quickly made by short pieces of spiral springs. The battery is charged by filling the glasses half full of water, adding some bisulphate of mercury, and a little shred of cloth is interposed between the plates, so as to retain moisture. To use this battery, we invert it, and thus allow the fluid to flow over the plates and saturate the piece of cloth. Restoring the battery, the fluid leaves the plates, though a drop remains in the cloth shred, and in this state, simply from these drops of moisture, powerful intensity currents, producing

violent muscular contractions, are given off, and this is the case even forty-eight hours after the immersion of the plates. It is evident that if we can employ these currents, resulting from the simple expenditure of one drop of the fluid, usefully, that we have exhausted a very small portion of the force in reserve, and it is also evident that we can, after use, place the battery out of use for an indefinite time, ready, by the expenditure of another drop of fluid, to give off the desired currents. Properly constructed, we cannot see any reason why the arrangement should not last in good power a year or more for occasional effects; and it can be completely renewed, at the rate of fifty cells in one hour; one hundred and fifty cells exceed in intensity one hundred cells of Grove. The parts are all quickly replaced, no acid is used, and no gas generated.



The second figure shows a modification of the construction. Supposing we wish to employ a fluid of greater energy, but which in decomposition produces gas from which the tight cell must be relieved; we insert a tube through the cover; the opening being just half way down the cell, and the surface of the fluid below. Care being used in inverting the battery, this tube orifice is always in the air space of the cell, whether upright or inverted. When we wish for convenience a battery of large quantity, to be used occasionally, we employ large glasses and elements; but we substitute bolts for the rubber bands, to bind down the zinc covers. An exceedingly convenient battery is thus formed for electric cauterization, where the operation is not too extended. The use of the rubber bands, however, in batteries of high tension, is far preferable to bolts, or their equivalents. The very high insulation of this packed battery is evident from the retention of its power for forty-eight hours and more, where the exciting power is derived from a mere drop of fluid.

FLAME REACTIONS.

By Prof. Bunsen.

Translated by Prof. Charles F. Himes, Ph. D., Dickinson College, Carlisle, Pa.

(Continued from page 200.)

VIII.—Behavior of Lead Compounds.

A. *Flame coloration*, pale blue.

B. *Reduction incrustation*, black, dull or brilliant.

C. *Oxide incrustation*, bright ochre-yellow; proto-chloride of tin produces no reaction, also not after the addition of hydrate of soda; nitrate of silver produces no coloration either alone or after ammonia has been blown upon it, or after it has been moistened by it.

D. *Iodide incrustation*, egg-yellow to lemon-yellow, insoluble when breathed upon or moistened; disappears when ammonia is blown upon it, and upon warming it reappears.

E. *Sulphide incrustation*, through brown-red to black, insoluble in sulphide of ammonium when it is blown upon it, or when moistened with it.

F. *On charcoal rod with carbonate of soda*, gives a gray, very soft, ductile, metallic grain, which dissolves with considerable difficulty, though completely, in not too concentrated nitric acid, to a white, easily crystalizable salt, which is soluble in water, and upon the addition of a few milligrammes of sulphuric acid, by means of a capillary pipette, gives a white precipitate.

IX.—Behavior of Cadmium Compounds.

A. *Metallic incrustation*, black, with a strong brown coating.

B. *Oxide incrustation*, dark brown, passes through brown into a white, therefore invisible, coating of sub-oxide of cadmium, which is not changed either by proto-chloride of tin alone, or after the addition of hydrate of soda; nitrate of silver on the other hand without ammonia, produces upon it a blue-black coloration of reduced metallic cadmium, which is very characteristic, and does not disappear with ammonia.

C. *Iodide incrustation*, white, not colored with ammonia.

D. *Sulphide incrustation*, lemon-yellow, insoluble in liquid sulphide of ammonium.

E. *Reduction on charcoal rod with carbonate of soda.* The metal, on account of its volatility, is only reduced with difficulty, and incompletely in this way, to a silver-white ductile globule.

X.—Behavior of Zinc Compounds.

A. *Metallic incrustation*, black, with brown coating.

B. *Oxide incrustation*, white, and therefore invisible. In order to test it, it is rubbed upon a piece of not too fine filter paper, a square centimètre in size, which is moist with nitric acid, and which is then held between two rings of fine platinum wire, three millimetres wide, and burned. If the paper is burned in the upper oxidizing flame at the lowest possible temperature, the ashes form a white, solid film, which can be ignited without fusing, and whilst gently heated appears lemon-yellow, but upon cooling becomes white again. If this film is moistened with several milligrammes of very dilute cobalt solution, and ignited, it appears, after cooling, of a very beautiful green color. It need scarcely be stated, that the same reaction can also be obtained with the metallic incrustation. Proto-chloride of tin, with or without hydrate of soda, as well as nitrate of silver, with or without ammonia, produces no reaction.

C. *Iodide incrustation*, white; not easily recognizable, either alone or after ammonia has been blown upon it.

D. *Sulphide incrustation*, also white, not clearly recognizable, either alone or when moistened with sulphide of ammonium.

E. *Reduction on charcoal rod*, does not succeed on account of the volatility of zinc.

XI.—Behavior of Indium Compounds.

Indium is detected with most ease and certainty by means of the spectroscope. I therefore give the reactions in this place simply for the sake of completeness.

A. *Flame coloration*, intense, pure indigo blue.

B. *Metallic incrustation*, black, with brown coating, at one time dull, at another brilliant. It disappears instantly with nitric acid.

C. *Oxide incrustation*, yellowish-white, scarcely visible; gives no reactions with proto-chloride of tin and silver solution.

D. *Iodide incrustation*, also yellowish, nearly white, invisible, if weak, with and without ammonia.

E. *Sulphide incrustation*, also yellowish, nearly white, scarcely visible, unchanged by sulphide of ammonium.

F. *Reduction with carbonate of soda on charcoal rod*, takes place with difficulty, and affords silver-white, ductile globules slowly soluble in hydrochloric acid.

A summary view of the incrustations of the elements thus far considered, is given in the accompanying table.*

XII.—Behavior of Iron Compounds.

A. *Reduction on charcoal rod*, gives no metallic grains, or ductile spangles with metallic lustre; the finely powdered metal forms upon the magnetic knife blade a black tuft without metallic lustre; when this is wiped off on to paper, and nitric acid and some hydrochloric acid are dropped upon it, it gives upon warming over the flame a yellow spot, which acquires a deep blue color of Prussian blue when moistened with ferrocyanide of potassium. The original yellow spot moistened with soda solution, and then hung for a few moments in the vessel with bromine vapor, does not give a spot of sesquioxide upon again moistening it with hydrate of soda.

B. *Borax bead*, oxidizing flame,—hot—yellow to brownish-red, cold—yellow to brownish-yellow; reducing flame,—bottle-green.

XIII.—Behavior of Nickel Compounds.

A. *Reduction on charcoal rod*, gives, upon pulverizing the charcoal, white, shining, ductile metallic spangles, which form a tuft upon the magnetic knife. The metal gives a green solution upon paper with nitric acid, which, after hydrate of soda has been dropped upon it, and it has been hung in bromine vapor and again touched with hydrate of soda, changes into a brownish-black spot of sesquioxide of nickel. The ashes of the paper, after it has been freed from hydrate of soda by rinsing, can still be used for the reaction with the borax bead.

B. *Borax bead*, oxidizing flame,—dirty violet-gray brown. Upper reducing flame,—gray, on account of metallic nickel, which often unites to form silver-white nickel sponge, whilst the bead becomes colorless.

XIV.—Behavior of Cobalt Compounds.

A. *Reduction on charcoal rod*, gives, upon pulverizing the charcoal, like nickel, ductile, white, shining, metallic spangles, which form a

* The table will be given with the number containing the end of this paper.

tuft upon the point of the magnetic knife. The metal wiped off on to paper gives, when nitric acid is dropped upon it, a red solution, which, when moistened with hydrochloric acid and dried, produces a green spot, which disappears upon moistening again. The paper with hydrate of soda placed in bromine vapor, and again moistened with hydrate of soda, manifests a brownish-black spot of sesquioxide of cobalt. The reaction is even very evident with a few tenths of a milligramme of metal. The paper, after rinsing off the soda solution, can also be burned and used for coloring the borax bead.

B. *Borax bead*, oxidizing flame,—deep blue bead, which does not change in the lower reducing flame. When treated for a considerable time alone, or better still with platin-chloride of ammonium, in the most energetic upper reducing flame, is completely decolorized, but only after long treatment, with the separation of cobalt or platin-cobalt.

XV.—Behavior of Palladium Compounds.

A. Palladium compounds are reduced upon fine platinum wire, with soda in the upper *oxidizing flame*, to a gray mass, similar to platinum sponge, which, when rubbed in an agate mortar, gives shining, ductile metallic spangles. The spangles, rinsed and dried upon a piece of a chemical flask, dissolve in nitric acid with reddish-brown color. If a small drop of a solution of cyanide of mercury is added to the liquid, a white flocculent precipitate is obtained, which dissolves in ammonia dropped upon it. After evaporation, and boiling with aqua regia, the liquid evaporated to a small drop, gives a dirty orange-yellow, crystalline precipitate of ammonio-chloride of palladium.

B. *Solution of palladium* is colored blue, green, and brown, by proto-chloride of tin, according to the addition of the same.

XVI.—Behavior of Platinum Compounds.

Platinum compounds give, when ignited upon fine platinum wire with soda in the upper *oxidizing flame*, also a gray spongy mass, which, by rubbing in an agate mortar, is converted into shining, silver-white, ductile metallic spangles. These are insoluble either in nitric or hydrochloric acid alone, but with aqua regia give a bright yellow solution, if the platinum is pure; if it contains rhodium, iridium, or palladium, they give a brownish-yellow solution. When solution of cyanide of mercury is added to the solution, and ammo-

nia blown upon it, no white flocculent precipitate is formed, but immediately a bright egg-yellow, crystalline precipitate of platin-chloride of ammonium.

B. Proto-chloride of tin colors solutions of platinum yellowish-brown.

XVII.—Behavior of Iridium Compounds.

These ignited in the *upper oxidizing flame* with soda, are likewise reduced to metal, which, when rubbed in an agate mortar, forms a gray powder without lustre, and not in the least degree ductile. This is not only completely insoluble in nitric or hydrochloric acid, but also in aqua regia.

XVIII.—Behavior of Rhodium Compounds.

These are only distinguished from the iridium compounds by the fact, that the metallic powder, insoluble in aqua regia, when fused with bisulphate of potassa, is partially oxidized, and affords a rose-red solution.

XIX.—Behavior of Osmium Compounds.

These give in the oxidizing flame volatile osmic acid, of a pungent odor, similar to chlorine, and which irritates the eyes.

XX.—Behavior of Gold Compounds.

If only traces of gold are present, mixed with a considerable quantity of gangue, it can only be concentrated and detected according to the old process for testing for gold.* Otherwise even a few tenths of a milligramme can be recognized by reduction with soda on a charcoal rod. The yellow, shining, ductile, metallic grain obtained in this way, can be reduced to spangles having the lustre of gold, by rubbing in an agate mortar. These are insoluble in hydrochloric or nitric acid, but give, rather readily, with aqua regia a bright yellow solution. If this is soaked up into a piece of blotting paper, and touched with proto-chloride of tin, purple of Cassius is formed. What remains upon the glass is colored brown by a solution of proto-sulphate of iron, by reason of separated gold, whilst the liquid appears blue by transmitted light.

* C. F. Plattner's Blow-Pipe Analysis.

XXI.—Behavior of Silver Compounds.

If silver occurs in traces in slag or complex ores, it can likewise only be detected by the old process, generally employed, of cupellation.*

If the silver compounds are not associated with entirely too large a quantity of foreign matter, even very small quantities can easily be detected by treatment with soda on the charcoal rod. The white, ductile grain of reduced silver dissolves readily in nitric acid, by warming moderately, and with hydrochloric acid, gives chloride of silver, which may be recognized by its behavior toward nitric acid and ammonia. By this reaction, even less than $\frac{1}{10}$th of a milligramme of silver can be detected easily and with certainty.

XXII.—Behavior of Copper Compounds.

A. *On a charcoal rod, with soda*, copper compounds give a ductile, shining metallic grain, which can easily be recognized by its copper-red color. By rubbing and decantation, metallic spangles are obtained, which can be rinsed, and easily dissolved in nitric acid, in a small glass capsule. The blue solution gives on a strip of paper a brown precipitate, with ferrocyanide of potassium. Instead of using the glass capsule, the solution and testing of the metal can be undertaken at once, upon a strip of filter-paper moistened with nitric acid.

B. *With borax on platinum wire*, give a blue bead, which can easily be converted into a reddish-brown bead of sub-oxide of copper, after the addition of very little binoxide of tin, but not alone. If it is repeatedly alternately reduced and oxidized in the lower oxidizing and reducing flames, it is easily possible to obtain a transparent glass, colored ruby-red by sub-oxide of copper, especially if the reduced bead is allowed to oxidize very slowly.

XXIII.—Behavior of Tin Compounds.

A. *On a charcoal rod*, the compounds of tin are easily reduced to white, shining, ductile metallic grains. The metallic spangles, obtained by rubbing these, dissolve with difficulty upon a piece of glass, in a drop of hydrochloric acid, and the solution soaked up on to blotting paper, gives a red precipitate with selenious acid, and a black one with tellurous acid dissolved in hydrochloric acid. If

* C. F. Plattner's Blow-Pipe Analysis.

a *trace* of dissolved nitrate of bismuth is added to the solution, an excess of hydrate of soda will produce a black precipitate of binoxide of bismuth. The metal when treated with nitric acid, gives white, insoluble binoxide of tin.

B. *In a borax bead*, which is colored *faintly* bluish by oxide of copper, the smallest traces of a tin compound can be detected with great certainty, since the bead, in the *lower reducing flame*, is colored reddish-brown and ruby-red, as was stated under copper compounds.

(To be continued.)

HOVER'S CARBONIZED PAPER.

By Hector Orr, Esq.

Read at the Meeting of the Franklin Institute, February 19th, 1868.

The consumption of paper in the United States, for writing and printing purposes, is enormous; far exceeding the proportion of a similar population in any other part of the world. The demand for printing-paper alone is so immense, that this variety of the article has overshadowed all others, and seems to have nearly monopolized the attention of manufacturers. The selection and preparation of the material, and the finishing of the surface, have drawn out much ingenuity and skill; yet the application of color in the process of printing is a simpler operation than that employed by the smallest school boy in his first lesson in writing. In printing, we place a definite amount of coloring matter, in a state of minute mechanical division, upon a contrasting surface, simply laying the ink on, and leaving it to harden by the slow absorption of its fluid parts.

In writing, however, in addition to all other adaptations, a chemical action is indispensable; we need the contact of both air and light to make the record legible and lasting. Writing with ink, is, in fact, a minute dyeing process, in which a particular color is both produced and fixed by chemical affinity. Yet these conditions seem to have had but little consideration from paper makers. The demand for material has become so urgent that other substances beside linen have been pressed into service. The bleaching salts, made necessary by the use of discolored stock, disturbs the shade of the ink, while the shorter fibre of cotton produces a *piling* on the surface, to allay

which various devices have been resorted to, which leave the sheet glassy and almost unimpressible by the ink.

Indeed, when we examine the actual process of paper making, we are surprised at the unlikely means there employed for the desired end. Our paper is literally *felt*, or matted pulp, of several varieties of vegetable fibre,—the natural union of whose particles has been changed by friction and immersion in water, and the material then brought into artificial contact through farther agitation by ingenious machinery, thus interlacing the fibres,—and which, starting at the trough as a wet *cobweb*, by means of heat and graduated pressure, in a few moments ends in finished paper, such as we are all familiar with.

Almost the only difference made by the manufacturer between printing paper and writing paper, thus far, has been the application to the latter of a glutinous wash or sizing, which presents a moderate resistance to fluids, and thus restricts the ink to the exact track of the pen's point, but which, at the same time, causes the ink to stand upon the surface for some time, and while hindering it from spreading, increases the danger of blotting.

On such a substance, so prepared, to find ourselves tracing a fine steel point for hours together without tripping, and *staining in* thousands of delicate characters, each definite and peculiar, is almost wonderful; while the new material employed in pens (a finely sensitive metal), drying and condensing the ink sooner on the pen than on the paper, and requiring a fluid almost colorless when applied, seems to bring the difficulty to an aggravating height. And it is just at this exhaustion of our patience that relief appears in the shape of this CARBONIZED PAPER.

Our writing ink (with trifling variations of proportions), is a compound of sulphate of iron, extract of galls, and gum, held in mechanical union by soft water. When this fluid is applied to the paper, as hitherto made, the following chemical action ensues: the oxygen of the atmosphere forms gallic acid with the tannin of the galls, which, in turn, unites with the iron of the copperas, forming a black precipitate (the per-gallate of iron), and the sulphuric acid, thus set free, enters the body of the paper, while the water passes off by evaporation.

Now this presence of sulphuric acid in the tissue of the paper is not a desirable result. At least it promises no good, and may produce harm. It adds nothing to the permanence of the color, and it may eventually act injuriously upon the very fibre of the paper.

In the Carbonized Paper, however, a new agent is introduced which acts both promptly and powerfully. The carbonate, equally diffused through the whole mass of the paper, is seized on with avidity by the sulphuric acid, forming a sulphate which at ordinary temperature may be considered a permanent compound, while the iron thus suddenly released, unites immediately with the gallic acid, producing the deep, black color so desirable in ink; and the carbonic acid, displaced from the carbonate, may be said to put the sulphuric acid under bonds for good behavior, and yet have no hurtful reac tion itself upon either the ink or paper.

It is rarely that we find even a radical improvement on a former practice at once so happily adjust its operation, and carry palpable advantage through all its ramifications.

I have already alluded to the process of letter-press printing as distinguished from handwriting. Printers, hitherto, have had no such assistance in applying their color as this invention offers to the penman; but I am not without hope that it may yet be extended to the art which preserves and promotes all others.

From an earlier period than I can specify, printers have chosen to "work" their paper in a damp condition, having a moderate quantity of water equally diffused through each sheet. In the anxious round of a day's work full of nice practical details, though continued for a lifetime, few will find opportunity or inclination for a philosophical examination of the particular process employed. I have been unable to satisfy myself that this wetting of the paper does anything more than slightly turn back the texture towards its former condition of pulp, raising a minute nap perpendicularly and spreading the fibres horizontally (I have frequently known sheets to spread one inch in twenty-four). Into this new surface the types bury themselves and undergo a slight *wiping* under the pressure, and then when the water is afterwards driven out by evaporation, the fibres knit over the ink, and each sheet also receiving heavy pressure between smooth pasteboards, the nap is laid down, and the ink is thus held mechanically on the paper. This is the best account I can give why our finely printed books do not soil in handling, as a damp newspaper does when fresh from the press.

The public in general is perhaps not aware of the advance in speed that letter press printing has attained in our age. Within my own experience we have passed from five hundred impressions

per hour, to *twenty thousand* impressions in the same time from a single surface!

In this rapid movement, we are thwarted principally by the crude mechanical application of color already described. The "second impression" (that applied to the opposite side of the sheet), following so rapidly after the first, that the ink has no time to seat itself in the paper, and hence "sets off" (as we say) on the tympan sheet, which soon becomes soiled and blurs the first impression.

I therefore think that if we could establish a chemical action between the paper and the ink, this grave impediment would be at least abated. We then need apply less color, and that in a more fluid condition than now, and have it adhere more firmly to the surface.

As the process is a Philadelphia invention, I hope our scientific members will spare it a little thought. This is part of my excuse for thus presenting it. I have presumed also a little on the consideration due our old brother printer whose name our Institute has chosen for its special distinction. And here I will leave the matter for the present.

METHOD OF QUALITATIVE ANALYSIS OF ANIMAL AND VEGETABLE COLORING MATTERS BY THE SPECTRUM MICROSCOPE.

By H. C. Sorby, F. R. S., &c.

(Concluded from page 205.)

From the Proceedings of the Royal Society, No. 92.

20. *Sub-groups.*

Since the narrow absorption-bands are decidedly the most important means of identification, it appears to me that we cannot do better than adopt subdivisions founded on *their number*. We may thus divide each group A, B, and C into sub-groups, in which the neutral aqueous solutions exhibit 0, 1, 2, 3, &c. decided absorption-bands. Sometimes one of them may be so obscure that we may hesitate whether it should be counted or not; but practically this is no very serious objection, if we decide to reckon only distinct bands, and to look on the fainter as important merely in identifying individual colors. If no absorption-band can be seen in the neutral solution, we may take into account those seen when more or less ammonia is added; and if none occur in either case, we may make use of those seen in the alcoholic solution when neutral, and after the addition of ammonia. Whenever in this order of experiments

the solution gives any decided absorption-band, the sub-group is determined; and it is only when none is produced that the process must be carried further.

The general connection of the sub-groups will be best seen from the following table:

$$1,\ \mathrm{A}\ \begin{cases} aq_0 & \begin{cases} am_0 & \begin{cases} al_0 & \begin{cases} am_0 \\ am_1 \\ am_2, \&c. \end{cases} \\ am_1 & \begin{cases} al_1 \\ al_2, \&c. \end{cases} \\ am_2, \&c. \end{cases} \\ aq_1 \\ aq_2 \&c. \end{cases}$$

The same system is applicable to each division, 1, 2, and 3, and to each group, A, B, and C. We can easily express the sub-groups by using one or more of the signs *aq*, *am*, *al*, *am*, with a figure to indicate the number of bands in the first term that contains any; those before it being given to show the facts more clearly.

Each color can be indicated by writing after the sub-group the characteristic spectrum, or, for the sake of simplicity, merely the position of the *centres* of the bands, when they are seen as independent as possible of general absorption. If the centres of the bands are in different positions the colors cannot be the same; but if they agree it does not necessarily follow that they are the same. It is probable, but must be further proved by the correspondence of other spectra. As examples, I give a few well marked cases.

Purple Pansy, ...	1, A, $aq_0\ am_1$ (4).
Crimson Rose, ...	1, A, $aq_0\ am_0\ al_0\ am_1$ ($2\frac{1}{2}$).
Blue Lobelia (*L. speciosa*), . .	1, B, aq_2 ($2\frac{3}{4}$, $4\frac{1}{4}$).
Pink Stock (*Matthiola annua*), . .	1, B, aq_2 ($3\frac{5}{8}$, $5\frac{1}{4}$).
Several blue species of *Campanula* .	1, B, aq_4 ($2\frac{3}{8}$, 4, $5\frac{3}{8}$, $7\frac{1}{4}$).
Brazil-wood (*Cæsalpinia crista*), .	1, C, aq_1 ($5\frac{1}{4}$).
Logwood (*Hæmatoxylum campechianum*),	1, C, aq_1 ($4\frac{3}{8}$).
Sandal-wood (*Pterocarpus santalinus*),	3, C, aq_2 (6, $7\frac{1}{2}$).
Alkanet-root (*Anchusa tinctoria*), .	3, C, aq_3 ($4\frac{1}{4}$, $5\frac{3}{4}$, $7\frac{1}{4}$).

21. *Individual Colors.*

Having then ascertained to which sub-group any particular color belongs, it is in the next place requisite to determine what particular substance it is. When it gives rise to well-marked absorption-bands, this may be more or less definitely decided by their exact position and character; since they may of course occur in different situations, or vary much in absolute and relative breadth and in intensity. Thus, choosing closely related spectra, we have, for example,—

1, B, aq_2

Blue *Lobelia speciosa* . . . $2\frac{1}{4}$—$3\frac{1}{4}$ ... $3\frac{3}{4}$*—$4\frac{5}{8}$ 11 ...

Pink *Matthiola annua*, . . $2\frac{3}{4}$*---$4\frac{1}{4}$...$4\frac{1}{2}$*---$5\frac{1}{2}$...8 10..11—
1, C, aq_1

Logwood (*Hæmatoxylum campechianum*), $3\frac{5}{8}$*—$5\frac{1}{4}$...7--8—

Brazil-wood (*Cæsalpinia crista*), . . $4\frac{1}{2}$*—$5\frac{3}{4}$..7--8—

Such spectra are at once seen to differ most decidedly when compared side by side; and that the coloring matters are entirely different is proved by other facts. If the absorption-bands agree very closely, we ought to compare other spectra before concluding that the substances are the same.

22. *Mixed Colors.*

Of course, if any impurity is present which absorbs that part of the spectrum where the characteristic bands occur, it may be difficult, or even impossible, to determine the nature of the substance; but the rest of the spectrum may be obscured, and the general color entirely changed, without the least difficulty being thereby produced. Thus, for example, on adding a solution of Saffron (*Crocus sativus*) to that of the blue *Lobelia*, the color is changed from blue to a curious olive, and the spectrum becomes—

Lobelia and Saffron, ... $2\frac{1}{4}$*—$3\frac{1}{4}$...$3\frac{3}{4}$*—$4\frac{5}{8}$ $6\frac{1}{2}$..7-—

Lobelia . . . . . $2\frac{1}{4}$*—$3\frac{1}{4}$...$3\frac{3}{4}$*—$4\frac{5}{8}$ 11...

Difference . . . . . $6\frac{1}{2}$..7-—

If we did not know it, we might thus infer that they were the same substance, and only differed because one contained a yellow color; and this conclusion would be borne out by adding to each citric acid and sulphite of soda, which make the *Lobelia* colorless, and leave the residual yellow color, $6\frac{1}{2}$..7-—, in the case of the mixture. The petals of very many flowers do really contain more or less of such a yellow, which appears to be that developed to a much greater extent in the stamens, &c.; and though this often modifies the general color and the spectra, its presence may be recognized in a similar manner. Different species of *Dianthus*, various kinds of Roses, and *Digitalis purpurea* are good examples of one general coloring-matter modified in this manner. Its normal character is—

1, A, $aq_0\ am_0\ al_0\ am_1$ ($1\frac{3}{4}$*--$2\frac{1}{4}$...$4\frac{1}{2}$ 11..).

In studying mixed colors, so much depends on their special characters, that it would be difficult to give any other general rules; and particular cases do not form part of the plan of the present paper.

23. *Spectra with no bands.*

The principal difficulty to be contended with in this method of qualitative analysis, is in the case of the sub-groups, where no decided absorption-bands can be developed by any of the re-agents. They can be easily divided into the groups A, B, and C, but the difficulty is to distinguish the separate colors, if we are not sure that they are pure and simple. Sometimes special facts may be of use; but, as a general rule, we are compelled to have recourse to the position and character of the general absorption. This requires a good deal of care, since a difference in the state of the solution may make the same color differ more than two quite distinct colors. After trying a number of experiments, I find that the best spectra for comparison are those obtained by adding first a moderate excess of carbonate of soda, and then a considerable excess of citric acid. Both of these solutions change very slowly, and give well-marked spectra; whereas ammonia often causes decomposition, and weaker alkalies or acids give much more faint spectra, or such as rapidly fade. Closely related colors should be compared together, and made as nearly equal as possible after the addition of the carbonate, and then citric acid added in considerable, and nearly equal excess. We thus can compare two different spectra; and even if the position of the absorption is the same in both cases, the relative intensity may vary considerably. Very closely allied colors may often be easily distinguished in this manner, and the only great difficulty is when colored impurities are present. As an example, I give some colors belonging to sub-group 1, B, $aq_0\ am_0\ al_0\ am_0$.

	Carbonate of Soda.		Citric Acid
Petals of Wallflower (*Cheiranthus Cheiri*)	2¼..--.5	8..9--10—	3¾..---..7
Dark grapes	2¼..--5¾...9	10..11--	4¼..---..8½
Fruit of Elder (*Sambucus nigra*)	2¼..--6..9	11...	4½..---..8½

The first differs entirely from the latter two, but they are so similar that it requires great care to be sure that they differ essentially. If it were quite certain that such colors were pure, it would not be difficult to distiuguish them with confidence; but since they may contain colored impurities, we must occasionally be content with results somewhat doubtful in questions of minute detail, which might not be of the least importance in some practical investigations.

24. *Yellow Colors.*

One of the best general methods of distinguishing yellow colors belonging to sub-group C, $aq_0\ am_0\ al_0\ am_0$, or those with bands which are much alike, is to make them as nearly as possible of the same tint when neutral, and then to add excess of ammonia, which may make them very unequal. For example:—

	Neutral.	Ammonia.
Yellow Dahlia (*D. variabilis*) . .	8..9--10—	3...4--4½—
Yellow Calceolaria (*C. aurea floribunda*)	7...9--11—	6¼..6¾--7—
Saffron (*Crocus sativus*)	7...8--11—	7..8--11—

The action of ammonia thus shows that they differ very much, but at the same time the *Calceolaria* might be a mixture of the other two, and this would have to be decided by other facts.

25. *Fading of Group C.*

Sometimes in examining colors of group C, advantage may be taken of the different rate at which their acid solutions decompose and fade, when a considerable quantity of sulphite of soda has been added to an acid solution. The two solutions should be made as nearly equal as possible in all respects, and then the rate of fading may prove that they are very different, or may show that one is a mixture. After fading, the addition of excess of ammonia may show valuable facts. For example, the color of the root of the red beet (*Beta vulgaris*) is pink, but that of the leaves is red; the spectrum differing from that of the root merely in having the blue end much absorbed. On keeping acid solutions of both to which sulphite of soda has been added, that of the root becomes colorless, and that of the leaves yellow; and thus, considering that acid solutions of colors belonging to group C are very rarely pink, it is almost certain that the color of the leaves is the same as that of the root, but modified by the yellow color so common in leaves.

26. *Conclusion.*

Such, then, is a general outline of the method which I have hitherto found the most convenient in studying different coloring matters, and for determining to what individual species any particular color may belong. I need hardly say that it is just the sort of qualitative analysis to employ in detecting adulterations in many substances met with in commerce, as well as in inquiries where very small quantities of material are at command. By this method we might be able in a few minutes to form a very satisfactory opinion, or at least one that might meet all practical requirements, and even under unfavorable circumstances we might narrow the inquiry to a surprising extent; and if this can be said even now, surely further research cannot fail to make it most useful in cases where ordinary chemical analysis would be of little or no use.

EDUCATIONAL

THE MAGIC LANTERN AS A MEANS OF DEMONSTRATION.

MONOCHROMATIC LIGHT.

(Continued from page 208.)

THE difficulty of producing monochromatic light in great quantity, prevents us from demonstrating satisfactorily, many points of interest in connection with the composition of light and the theory of vision. Colored glasses placed in the path of powerful beams of white light, are doubly unsatisfactory; they reduce the amount of light enormously, and with few exceptions (eg. red glass colored with gold), yield a beam of mixed color.

The old experiment of snap-dragon, or the spirit lamp with salted wick, are admirable, as far as they go, but yield a very faint light at best. Something far superior to this is furnished by the arrangement of a ring of cotton wick wound on a wire and supported immediately over and around a large Bunsen burner, the wick being soaked with an aqueous solution of some flame-coloring salt. This plan in effect, is suggested in Sir David Brewster's Natural Magic; but as theBunsen burner was not then known, a less simple arrangement is described to perform the same office.

The drawbacks to this arrangement are, the trouble of adjusting the cotton wicks, the delay in changing to produce a new color, and the brief duration, and to a certain extent, irregular amount of the effect. After lighting, the burners increase their effect to a certain point, and then soon rapidly diminish in the intensity of their light.

When a large number of burners are to be used, these difficulties become serious, and I have therefore devised the following arrangement, which has proved, on trial, thoroughly efficient. The burners to be used, varying in number from 5 to 30 in different experiments, are enclosed below, in a box with a single large entrance, opposite to which is placed an atomizer, operated either by steam or compressed air.

A spray of the coloring solution is thus mixed with the air supplying the burners, and their flames are tinged with the greatest ease, certainty, and intensity of effect, the whole action being

entirely under control, and capable of being maintained indefinitely, while the change from one color to another is effected by simply transferring the tube of the atomizer from one solution to another. For experiments demanding diffused light, this apparatus is most satisfactory. Five large Bunsen burners thus arranged, light up the Lecture-room of the Franklin Institute, which seats about 350 persons, and with 60 burners arranged in two groups of 30, I expect to illuminate sufficiently at my next lecture, the Academy of Music, which has 3500 stalls. Of course, in neither case, is the light *brilliant*, but simply sufficient to show in the most distant portions of the room, the peculiar effects of this light on the faces and dresses of the audience themselves. Any object near the flame is, however, brightly illuminated.

The stage being set with the most brilliant scenery and colored decorations, suddenly illuminated by yellow light thus developed, the ordinary gas light being turned down, presents an appearance of ghastly change, which cannot be appreciated until seen, while sufficient light reaches all parts of the house to allow the audience to repeat the observation of strange metamorphosis upon their neighbors.

In certain experiments, however, it is necessary to have monochromatic light of great intensity and concentration.

This I have found could be furnished in the case of yellow light to a certain extent, by substituting in the gas microscope or polariscope, a soda glass rod for the ordinary line cylinder, and so adjusting its position that the rays from the heated glass should be cut off from the lenses, and only the light of the yellow flame should reach them.

We can thus show upon a screen 5 feet in diameter, the greatly increased number of rings developed by a section of Iceland spar, in monochromatic light.

With the spectroscope, we can also project the sodium line on the screen, so as to be well seen by an audience of 500 persons. By afterwards vaporizing a pellet of sodium in a small Bunsen, placed in the lantern and immediately in front of the lime, the black band due to absorption, and its identity in position with the yellow line, is also well exhibited. A full account of these arrangements will be found in this Journal, 1866, Vol. LI., p. 420; Vol. LII. p. 67.

ON THE FUTURE DEVELOPMENT OF SCIENTIFIC EDUCATION IN AMERICA.

By S. Edward Warren, C. E.

Prof. of Descriptive Geometry, &c., in the Rensselaer Pol. Inst., Troy, N. Y.

A great and increasing popular interest in both the general and technical knowledge of the physical sciences, has thus far found expression in the organization, and more or less successful career, of quite a number of institutions, principally devoted to the diffusion of such knowledge.

Institutions of the kind referred to exist, either independently or as parts of more comprehensive organizations, at Hanover, N. H., Cambridge, Boston, and Worcester, Mass., Troy, N. Y., New Haven, Conn., and at Philadelphia, and a few other places, with somewhat various requirements of age and attainments for admission, and with prescribed courses of study, ranging from two to four years in length.

So much having been secured, and the more advanced of these schools having well-established courses of study adapted to qualify young men, of proper ability, for fair engineering, or other like positions, at graduation, with prospect of rapid promotion, the question arises, What further development do these institutions need, and how shall it be secured?

Under the old or "classical" system of liberal, followed by professional, education, the student graduates successively from the Academy, the College, and the professional School of Law, Medicine or Theology.

This progressive order is very generally understood to be a proper one: and it is a generally recognized omission of an important section of one's entire intellectual training, to skip the collegiate stage, as many do, and pass from the academy to the professional school, without the intermediate collegiate training, which is designed to generously develop the *man* before making him a lawyer, physician, or other specialist.

The difference between professional life, which is, and that which is not founded upon collegiate training, *other things being the same*, is this: The former has breadth and general culture and acquirements which fit it to adorn the really best society, and which add finish and lustre to merely professional attainments, and which enable its possessor to bring to bear upon the intricacies of professional study and practice, a mind *already trained to exact and careful thinking.*

The latter, except as native force, ambition, and special diligence may conspire to enable one to cultivate himself liberally, may include but little beyond the routine of a profession, and thus may readily degenerate into a mere trade, in which, through comparative poverty of general mental acquirements, one naturally fails to rise to honorable distinction through the achievement of any notable results.

Such, at least, are the tendencies in the two cases, whatever exceptions may, from time to time, present themselves.

These views lend interest to the inquiry: How shall *scientific* training be so fully developed as to be distributed among a succession of institutions analogous to those which are mainly devoted to literature and abstract logic and philosophy?

We shall probably best find the way to a competent answer, by stating, first, what already *is*, and then what *might be;* first the *real*, and then the *ideal*, of systematic, organized, liberal and professional scientific education. And the former statement shall be made in connection with a parallel exhibition of the successive grades of institutions of the prevailing type.

We are well aware, in doing this, that there are those, doubtless, who question the possibility of a "liberal" education—that is, an effective development of the mental faculties into working powers, by the study, principally, of the mathematics and physical sciences. But we know, also, that many are well persuaded that this development can be secured by such means, and we are, therefore, content, for the present, to quietly assume that every mind, having any *polarity* to its life—that is, having marked preferences for some subjects of thought and research, rather than for others, will *thrive best on what it likes best.*

Only premising, further, what will be mentioned again, that these preferences do not generally manifest themselves decidedly at first, and that, therefore, elementary schools may properly be alike for all classes of minds, we proceed to exhibit, in parallel columns, the two lines of institutions before mentioned.

Primary Schools.	Primary Schools.
Intermediate Schools.	Intermediate Schools.
Grammar Schools.	Grammar Schools.
Latin High Schools and the Classical Departments of Academies and general High Schools.	*English* High Schools and the department of Modern Languages and Physical Science in Academies and general High Schools.

Purely Classical Colleges, or the classical departments in other colleges.	The "Scientific Course" in colleges having also other courses. Also the first one or two years of some of the *professional* or Polytechnic Schools.
Professional Schools of Law, Medicine, Divinity.	Strictly professional schools of Architecture, Civil Engineering, Mechanical Engineering, Mining and Metallurgy, Chemical Technology; or, the closing and strictly professional years of scientific schools, having also a preparatory year or two included in their total course.

By mere inspection, now, of the second column, the lack of order and unity, through lack of well-defined limitation of the general and the technical or professional grades of scientific education, is apparent.

The "scientific course" running parallel with the "classical" ones in common colleges, and the one or two earlier years in the polytechnic schools, overlap and interfere with each other. And hence it is that so few go through with these "scientific courses," with a view to a *subsequent* professional training in the higher classes of the polytechnic or *professional* scientific schools.

Again, the programmes of the latter schools, however high in theory and practice they may go, are lacking in some features, as compared with the requirements of engineering practice. This arises, first, from inadequate ideas on the part of the public as to the proper composition, breadth and depth of a course of professional training, involving the theory and practice of engineering, or architectural, or mining construction and management. Second, from the partly consequent difficulty of imposing upon students a course of more than four years, not separated into distinct successive divisions.

Classical colleges exist either separately or as separate components of broader or university organizations, in the American sense, of including a circle of professional schools of Law, Medicine, &c. But, in the latter case, there is a well-defined, distinctly-expressed, and well-understood separation between the collegiate course, as preparatory, and the professional schools, as successive, to the former. Now, since the polytechnic or professional schools have to educate the community as to what the depth and extent of the engineering and kindred professions are, they can, at present, at least, probably best do their own preparatory training for themselves.

When the scope and extent of the professions just mentioned are better understood, it may be equally well for the scientific schools to shorten their courses to two, or perhaps three, years of the most elevated and strictly professional instruction; and then, the very elevation of these requirements for admission, accompanied by suitable explanations, would stimulate the development of the "scientific courses" (not professional) in the colleges, and secure the attendance upon them of candidates for the succeeding *professional* schools of science.

But at present, we say we think the latter schools had best include this same preparatory course of general science within themselves, and also resolve themselves, explicitly, into two parts There should be, *first*, the foundation course of general scientific training, collegiate in its spirit and aim—that is, existing to *develope the native mental powers* of the students in it; and, *second*, the circle of truly professional schools, radiating from the general foundation course, as a governing centre and source.

In one or two instances, in this country, this *idea* is realized. It only then remains to *emphasize the expression of it* by a more conspicuous separation of the general from the truly professional stages of the total course of study, and to *amplify it* by adding a year, and raising the requirements for admission till a *cardinal feature* of the *professional* schools shall be lectures upon *higher engineering practice*, by the best experts in the several departments of engineering.

The practical exercises of all kinds, already given in the polytechnic schools, are, in the aggregate, quite extensive, and, in conjunction with an ample body of theory, actually do enable accomplished graduates to enter at once upon very fair professional positions, such as will compare very favorably with those of legal and medical graduates, and such as prove the higher portions, at least, of the instruction given in those schools, to be truly professional. Still, there is room for expansion in the same direction; and though no engineering schools could graduate a *Chief Engineer*, any more than a law school could a *Chief Justice*, yet they might profitably come nearer to qualifying their graduates for controlling positions and independent practice than they now do.

We have, then, the answer to our opening questions. *First.* The programmes of our polytechnic or *professional* scientific schools need to be both elevated and expanded, chiefly in the manner just indicated. *Second.* This result is to be secured by a more complete

separation between the foundation general course and the succeeding professional courses growing out of it, and by due adjustment of the conditions of admission.

Having thus rapidly reached this conclusion, let us, even at the risk of some repetition, proceed to discuss it more in detail.

The practical question then returns, how to cause the collegiate stage or grade of educational discipline to be recognized and appreciated in the second column of successive institutions, already given, as well as in the first one? In other words, how shall we dislodge the too prevalent idea that the student may, legitimately and profitably, skip the collegiate grade, and jump from the study of elementary science in the academies, to that of professional science, with all its imperious exactness and multiplied refinements, in the technical school?

Manifestly *not* by *permanently* joining hands between the two classes of schools, through the supplementary giving of elementary instruction in professedly technical ("scientific") schools of engineering, &c., as is now done.

But, on the contrary, by first effectually implanting in the public mind, adequate counteracting ideas, such as are expressed by the above table, of a two-fold system of education, each pursued through a succession of graded institutions, to its crowning conclusion.

Second, by animating these counteracting *ideas* with appropriately elevated *sentiments*, as viz: that to plunge into, and struggle through with, a merely professional training, without bringing to it, or carrying from it, any broad and comprehensive general culture, is to make one's merely professional learning a mere excrescence on an otherwise ill-developed intelligence, rather than as a crowning dome upon the capacious body of a well-proportioned mental structure.

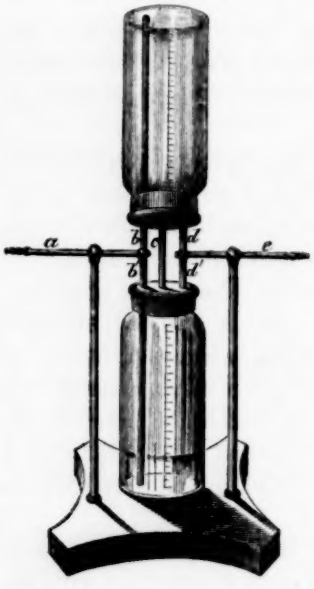
Also, that thus to pursue one narrow line of special study and practice, however far, tends to contract one's sympathies with the great general interests of the race, and to diminish the number of positions in which one can act well among and for his fellow-men. Thence, one's profession itself may, by reason of contracted views, be pursued in the merely trade spirit, or for gainful ends, rather than in the genuine professional spirit of honorable ambition for fame, and of pleasure in doing creditable and beneficent service to man.

(To be continued.)

GASOMETER FOR ACCURATE MEASUREMENTS.

By Prof. Albert R. Leeds.

A very accurate form of gasometer, especially designed for the measurement of gases while in motion, and for prolonged experiments requiring the estimation of large quantities of gas, has been constructed in the following manner. Two half gallon bottles of fine white glass, and with the widest mouths obtainable, are accurately graduated to cubic centimètres at the standard temperature The divisions are carefully etched upon the sides of the bottles with hydrofluoric acid. A brass cap is cemented upon the top by means of plaster of Paris. The two bottles are placed one above the other, and connected by the system of tubes which is illustrated in the accompanying drawing; *a* and *e* are the entrance and exit tubes, firmly secured down by brass caps to the two wooden supports or pillars. They are corrugated at their outer ends, to allow of a tight connection with India rubber tubes, and closed at their inner ends. Through the upper side of the entrance, and the lower side of the exit tubes, at the distance of half an inch from their closed ends, an orifice is made for the flowing in and out of the gas. Through the caps a brass tube, B B′, passes to the bottom of the bottles. A similar tube, D D′, connected with the exit tube, terminates with the caps. A centre tube, C, passes a short distance beyond the brass plates which form the caps, and then turning back again until it comes almost in contact with the plate, after the manner of a hook, it forms a sort of water valve when the gasometer is in operation, which effectually prevents the escape of water from the upper vessel, except when there is at the same time a supply of gas furnished to it by means of the entrance tube. One of the bottles having been unscrewed from the cap, is filled with clear water, placed back in its proper position, and revolved until it is brought uppermost.



The system is nicely equipoised, and is kept from turning by little pegs let into the base at the sides of the lower vessel. When the gas is forced through the tube, A, it finds an orifice upon the upper and none upon the lower side, and consequently ascends into the top portion of the upper vessel. As it enters, a portion of water of equivalent volume is displaced and runs down through the centre tube. It cannot run through the tube, D, because there is no orifice in the upper side of the exit tube. As the water enters, the gas previously in the lower vessel, not being able to find its way out of the entrance tube, B′, even while for a moment, the end of that tube is not covered with water, on account of the absence of an orifice on the lower side of the main entrance tube, and not being able, moreover, to bubble up through the centre tube, on account of the water valve at at its termination, makes its way through the tube, D′, and the exit tube, E, out into the vessel arranged to receive it. As soon as the water in the upper bottle has fallen to the level of the brass rim, the apparatus is reversed, the entrance and exit tubes serving as pivots to turn upon—and the flow of gas continues without interruption. The usual corrections for temperature and pressure must of course be applied to the volumes read off.

Franklin Institute.

Proceedings of the Stated Monthly Meeting, February 19th, 1868.

The meeting was called to order with the Vice-President, Mr. Coleman Sellers, in the chair.

The minutes of the last meeting were read and approved.

The minutes of the Board of Managers were reported by the Actuary, who reported that at their stated meeting on the 12th instant, the following resolutions were passed, viz:

Resolved, That the Board of Managers recommend to the Institute that the By-Laws be amended by omitting from the list of standing committees, the committee on exhibitions, as now in section 1st, Article X. And from the list of reports of standing committees, that from the committee on exhibitions, as now in section 2d, Article XII.

The following committees were then appointed by the President:

Library.	*Models.*	*Arts and Manufactures.*
John C. Browne,	James Agnew,	Wm. Adamson,
Robert Briggs,	J. Sellers Bancroft,	John H. Cooper,
Charles Bullock,	Wm. B. Bement,	Charles E. Foster,
Pliny E. Chase,	Edward Brown,	C. Eugene Meyer,
Samuel Hart,	Mordecai W. Haines,	Jacob Naylor,
B. H. Moore,	Addison Hutton,	Hector Orr,
H. G. Morris,	John Kile,	Wm. G. Rhoads,
Henry Morton,	Edward Longstreth,	Jas. B. Sand,
Percival Roberts,	Wm. B. Le Van,	John C. Trautwine,
Samuel Sartain.	John L. Perkins.	Henry R. Towne.

Meetings.	*Minerals.*	*Meteorology.*
Henry R. Cartwright,	Clarence S. Bement,	Sam'l Allen,
R. C. Cornelius,	John C. Browne,	Henry Bower,
Emile Geyelin,	Isaac H. Conrad,	Pliny E. Chase,
Robert Briggs,	Emile Geyelin,	Chas. M. Cresson,
H. G. Morris,	Robt. H. Lamborn,	Lemuel J. Deal,
Henry Morton,	Albert R. Leeds,	Jacob Ennis,
Robt. E. Rogers,	Theodore D. Rand,	Caleb S. Hallowell,
Coleman Sellers,	Robt. E. Rogers,	Jas. A. Kirkpatrick,
Thomas Shaw,	R. A. Tilghman,	Benjamin V. Marsh,
E. Y. Townsend.	Elias Wildman.	Henry Morton.

Sub-Committee on Scientific Proceedings at Meetings

R. Briggs, E. Geyelin, Henry Morton, R. E. Rogers, and Coleman Sellers.

A paper on carbonized paper was then read by Mr. Hector Orr.

Mr. Robert Briggs then made some remarks upon the structure of domes, after which some remarks were made Mr. H. R. Campbell, on railways for inclines.

The Secretary's report on Novelties in Science and Arts was read, after which the meeting on motion, adjourned.

HENRY MORTON, *Secretary.*

Bibliographical Notices.

Micro-Chemistry of Poisons. By Theo. G. Wormley, M. D.

A BOOK elegant in binding, paper, typography, and illustrations. The latter were drawn on steel by the accomplished wife of the author. Their beauty is such as to excite comment upon the first glance, but it is not until they are critically examined through a strong lens, that their perfection of finish and detail is appreciated.

Plate 1 gives the crystaline forms of the precipitates obtained with potash and bichloride of platinum, tartaric acid, and tartrate of soda, and of potash, ammonia and soda with carbazotic acid. Plates II. to VI. are devoted to the reactions of the other inorganic poisons. Sulphuric, hydrochloric, phosphoric, arsenious, arsenic acids, the salts of mercury, lead, zinc, &c., and the remaining seven plates to the minute crystals afforded by nicotine, morphine, strychnine, brucine, and the alkaloids in general, when submitted to the action of various reagents. The amounts tested vary from the one-twenty-fifth to the one-ten thousandth of a grain, and are exhibited under magnifying powers ranging from forty to two hundred and twenty-five diameters. Unfortunately the crystaline form is not stated in words, except in a few cases previously well known. It is not essential in a work of this description, it might be said, and the determination of these very difficult matters might well be left to an independent work on micro-crystalography. It is very much to be hoped for, that such a work should be written, as it is highly probable that the microscope will become a powerful instrument of research in chemistry.

Next in interest to these plates, are the numbers which are given to exhibit the limits at which the quantities of the poison present, cease to be capable of detection by the tests employed. They appear to have been determined in a very conscientious and painstaking manner. The ten-thousandth part of a grain of the poison is frequently much more than is sufficient for its detection, and the hundred-thousandth is sometimes ample. The instances of poisoning, cited from various authorities, are selected with discrimination, presented with critical care, and are designed to indicate the action of various quantities under divers circumstances, and in the cases of persons of widely different ages. The symptoms observable are fully given, and also the periods during which the action may be postponed, delayed by the presence of other bodies, protracted, and at which death usually ensues. The smallest quantities which have proved fatal, and the largest amounts which have been taken without producing death, are carefully stated. The medical jurist will object to the book, that it contains many confusing scientific details; the physician, that it has too much qualitative and quantitative analysis; and the chemist, that it has not only the pathological and physiological effects of poisons, but a great deal of their general chemistry, which is more fully stated in other works. But the design